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		p. 14	
		p. 23	
		p. 34	
		p. 35	
		p. 108	
		p. 60	
		p. 111	
		p. 121	
		p. 122	
		pp. 140, 141	
		Title Page	

THE UNIVERSITY OF ALBERTA

SOCIAL, PERSONALITY, AND ATTITUDINAL DIMENSIONS OF INDIVIDUAL LEARNING WITH COMPUTER-ASSISTED GROUP INSTRUCTION

by

© Glenn F. Cartwright

A THESIS

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ABSTRACT

A central principle of computer-assisted instruction (CAI) is that students are taught individually. Seldom has the teaching of groups of students by computer been considered. In this study, the group facilitation of individual learning with CAI is examined. In addition, the effects of certain social, personality, and attitudinal variables on individual learning with group CAI are considered.

During a summer course, 282 educational psychology students, selected for their lack of background knowledge in general psychology, were randomly assigned to one of four treatments. A control group worked with CAI individually, and three experimental groups worked with CAI in pairs, or in groups of three or four. Three CAI lessons in general psychology were presented, each a week apart. During the fourth week, each student responded individually to a criterion test of thirty multiple-choice items based on the lessons. No significant differences in mean individual learning scores of variances were found among the four treatment groups, suggesting that students

learned equally well whether taught by CAI individually or in groups.

It was found that personality measures such as locus of control, anxiety, extraversion, and neuroticism were unrelated to performance on the criterion. However, certain attitudes, for example those towards seminars and CAI, correlated positively with performance on the criterion. Attitudes towards CAI were not significantly changed as a result of experiencing CAI in groups.

With respect to on-line performance, no significant differences were found among the four treatment groups in the average amount of time required to complete the lessons, nor were there significant differences among the treatment groups in the mean number of correct on-line responses. Subjects who worked alone however, made significantly more total responses and tended to make more errors than did subjects who worked in groups. Further, it was found that for students who worked alone, performance on the criterion was significantly related to the number of on-line correct, incorrect, and unrecognizable responses made during the course of the lessons. For pairs of students, criterion performance was related only to incorrect and unrecognizable on-line responses. For groups of three and four students, performance on the criterion was unrelated to on-line performance.

Theoretical distinctions are made between the terms "individual" and "individualized" instruction, and between overt-covert and explicit-implicit types of responding. Differential interpretation of feedback is proposed in an attempt to explain how the learning of individuals in groups can be effected

independently of the nature of the group-entered responses.

Practical implications of the study are considered, including how the use of groups of four students per terminal can reduce the overall cost of CAI per student by seventy-five per cent. Suggestions are given for further research in the areas of motivation and retention, instructional design pertaining to both individual and group CAI, and the study of group process.

The study supports the view that, apart from reduced cost and other advantages, group CAI may be perceived by educators to be less dehumanizing and hence less threatening than conventional CAI, and therefore more acceptable as an instructional system.

Short Title of Thesis

COMPUTER-ASSISTED GROUP INSTRUCTION

Cartwright

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TABLE OF CONTENTS

Page

ACKNOWLEDGEMENT.. ii

LIST OF TABLES.. vi

LIST OF FIGURES.. vii

Chapter

I. THEORETICAL FRAMEWORK OF THE STUDY.............. 1

Description of Computer-Assisted Instruction
Current Development
Criticism of CAI
Dehumanization
Rigid Interaction
Economic Factors
Cost Reduction Approach
General Statement of Problem

II. REVIEW OF RELATED LITERATURE.................... 18

Introduction
Programmed Instruction
Learning in Groups
Background
Research Studies
Group Programmed Instruction
Background
Research Studies
The Absence of Self-pacing
Group Computer-Assisted Instruction
Personality Variables in Learning
Student Attitudes
The Time Variable
Summary of Chapter

Chapter | Page

III. STATEMENT OF THE PROBLEM AND RESEARCH DESIGN..... 51

Statement of the Problem
Learning Performance
Hypothesis 1
Attitude Change and Learning Performance
Hypothesis 2
Personality Variables
Hypothesis 3 - introversion-extraversion
Hypothesis 4 - neuroticism-stability
Hypothesis 5 - internal-external locus of control
Cost Factors
Hypothesis 6
Subjects
Research Design
Randomization
Procedure
Description of the Measuring Instruments
The Survey of Educational Opinions
Anxiety
Eysenck's Extraversion
Eysenck's Neuroticism
Internal-External Locus of Control
Criterion Learning Test
Teaching Methods Questionnaire II
Information Questionnaire
Software
The Programming Language
The CAI Lessons
Hardware
Data Collection
Summary of Chapter

IV. ANALYSIS OF THE DATA............................ 85

Overview of the Chapter
Results of the Analyses
Hypothesis 1 - Learning
Hypothesis 2 - Attitudes
Hypotheses 3, 4 and 5 - Personality Variables
Hypothesis 6 - Elapsed Lesson Time
Analysis of On-Line Responses
Summary of Chapter

Chapter | Page

V. DISCUSSION.................................... 109

Overview of the Chapter
Learning and the CAI Lessons
Learning and its Measurement
Learning Above Chance Levels
The Low Mean Scores
A. Retention
B. Motivation
The Lack of Learning Score Differences Among Treatments
Individualized Instruction in Groups
Differential Interpretation of Feedback
Response Mode
Classroom Learning and Group CAI
Group Work, Subject Matter, and Instructional Design
Attitudes
Personality
Elapsed Lesson Time and On-Line Responses
Cost Reduction
Reduced Dehumanization
Suggestions for Further Research
Motivation and Retention
Instructional Design
A. Design of Group Feedback Statement
B. Design of Group Programs
C. Design of Group Terminals
D. Design of Conventional CAI Programs
Individualized Instruction
Group Process
Group Composition
Longitudinal Studies
Summary of Findings
Learning
Attitudes
Personality
On-Line Performance
Cost Reduction
Conclusion

REFERENCES.................................... 149

APPENDICES.................................... 156

LIST OF TABLES

Table		Page
1.	TOTAL NUMBER OF STUDENTS YIELDING COMPLETE DATA.......	63
2.	TIMETABLE OF THE EXPERIMENT..........................	65
3.	THREE WEEK TEST-RETEST ON THE TEACHING METHODS QUESTIONNAIRE II....................................	77
4.	MEANS AND VARIANCES OF INDIVIDUAL LEARNING SCORES FOR THE FOUR TREATMENT GROUPS..........................	86
5.	ANALYSIS OF VARIANCE OF LEARNING SCORES FOR THE FOUR TREATMENTS..	87
6.	ADJUSTED ANALYSIS OF VARIANCE USING PRETEST ATTITUDE TOWARDS CAI AS COVARIATE, AND POSTTEST ATTITUDE TOWARDS CAI AS CRITERION............................	89
7.	ADJUSTED ANALYSIS OF VARIANCE USING PRETEST ATTITUDES TOWARDS PI AND CAI AS COVARIATES, AND POSTTEST ATTITUDE TOWARDS CAI AS CRITERION....................	91
8.	ADJUSTED ANALYSIS OF VARIANCE USING PRETEST ATTITUDES TOWARDS LECTURE, SEMINAR, TUTORIAL, PROGRAMMED INSTRUCTION, AND CAI AS COVARIATES, AND POSTTEST ATTITUDE TOWARDS CAI AS CRITERION....................	91
9.	INTERCORRELATIONS AMONG PRETEST ATTITUDES TOWARDS TEACHING METHODS, AGE, AND CRITERION TEST............	92
10.	ADJUSTED ANALYSIS OF VARIANCE OF CRITERION SCORES AMONG THE FOUR TREATMENT GROUPS USING LOCUS OF CONTROL, ANXIETY, EXTRAVERSION AND NEUROTICISM AS COVARIATES..	94
11.	PEARSON PRODUCT-MOMENT CORRELATIONS FOR AGE, CRITERION TEST SCORES AND PERSONALITY VARIABLES.......	95
12.	MEANS AND STANDARD DEVIATIONS OF ELAPSED TIME FOR THE FOUR TREATMENTS....................................	98
13.	ANALYSES OF VARIANCE OF ELAPSED LESSON TIMES FOR THE FOUR TREATMENTS....................................	100

Table Page

14. MEANS AND STANDARD DEVIATIONS OF AVERAGE NUMBER OF GROUP RESPONSES PER LESSON........................... 103

15. ANALYSES OF VARIANCE OF AVERAGE NUMBER OF GROUP RESPONSES OVER THREE LESSONS......................... 104

16. INDIVIDUAL SCORE MEANS AND STANDARD DEVIATIONS OF CRITERION TEST, AVERAGE CORRECT, INCORRECT AND UNRECOGNIZABLE RESPONSES FOR THE THREE LESSONS FOR THE FOUR TREATMENT GROUPS............................ 106

17. CORRELATIONS BETWEEN INDIVIDUAL CRITERION LEARNING SCORES AND AVERAGE NUMBER OF CORRECT, INCORRECT AND UNRECOGNIZABLE RESPONSES OF THE THREE LESSONS COMBINED.. 107

18. SUBJECT MATTER AND GROUP SIZE IN STUDIES OF GROUP PROGRAMMED INSTRUCTION AND COMPUTER-ASSISTED INSTRUCTION.. 126

LIST OF FIGURES

Figure

1. Conventional Computer-Assisted Instruction for Individuals.................................. 11

2. Group Computer-Assisted Instruction................. 16

3. Learning Through Differential Interpretation of Feedback.. 118

CHAPTER I

THEORETICAL FRAMEWORK OF THE STUDY

Description of Computer-Assisted Instruction

Computer-assisted instruction (CAI) attempts to control student instruction by means of a computer, eliminating direct teacher involvement. It accomplishes this by presenting learning sequences to the student and accepting and processing student responses to the material. Each response the student makes can be used to control further progression through the material, to diagnose student difficulties and provide remediation, and to keep accurate records of student performance for later analysis and subsequent lesson improvement. It is essentially an interactive system providing rapid feedback to the learner to gain optimal learning performance.

Methods of presentation of material by computer vary. The computer may be employed to present straightforward branching programs as in the present study, or may be used in sophisticated systems employing strategies having little resemblance to ordinary

programmed instruction (O'Day, Kulhavy, Anderson, and Malczynski, 1971). In "branching programs" the computer is used to switch to different parts of the course material or to remedial sequences, depending on the nature of the student's responses.

The actual presentations may be made by a near or distant computer, on typewriter-style or cathode-ray terminals, and by using computer-controlled random-access slide projectors and tape recorders. Student responses may be made by pointing to the screen with a "light-pen" or by typing in the response, depending on the characteristics of the particular CAI system.

More recent and sophisticated applications of CAI have been made in the areas of simulation and gaming. In simulation, the computer simulates the essence of reality, but without all the aspects of that reality (Twelker, 1970). Student dentists, for example, may practice their skills on simulated patients whose movements are controlled by a computer. Airline pilots are often trained in computer-controlled flight simulators.

In gaming, a games approach is programmed to assist students in learning various principles. Gaming is based on the premise that learning can be facilitated through pleasant and even stimulating competitive encounters in a games situation. The computer uses strategies which human players would ordinarily use to tie or defeat their opponents. If the player were simulating an economic planner,

the computer would evaluate his strategies and advise him as to his performance (Gordon, 1970). CAI gaming then, is a type of "media ascendant simulation" where techniques are applied which emphasize learning through vicarious experience mediated by a computer (Twelker, 1970).

CAI is not restricted by subject matter. Virtually any subject can be taught by CAI as long as the lesson material is arranged in relevant learning patterns and programmed in the CAI author language appropriate to the system. The authoring language represents the "language" or system of operating codes used to tell the computer what to do with the lesson material and responses of the students. A lesson is coded in the author language for execution by the computer. Such instructions might include the command to "display text", to "branch" to a different part of the lesson for further explanation or remediation, or to "process" an incoming student response. This authoring procedure of coding lessons is both costly and time-consuming, and has often been cited as a disadvantage of CAI.

Current Development

Little research is under way at the moment to improve CAI outside the hardware and software areas. Even research aimed at improving learning, centers on developing better lesson organization

and sequencing to optimize student performance. A great deal of research is aimed at developing better computer hardware and reducing overall costs. Little is done in researching the personality, attitudinal, and social characteristics of the learner in relation to the effectiveness of CAI. Furthermore, most existing research has been done within the context of so-called "individualized instruction". It is suggested that teaching machines and programmed instruction originated traditions which carried on with the introduction of CAI. To support this view, one must turn briefly to the history of the mechanized teaching movement.

The idea of a machine which could teach is not new. In fact, between the years 1809 and 1936, over six hundred teaching machines were awarded patents in the United States alone (Austwick, 1964). It is Pressey (1926), however, who is usually credited with being the "father" of the teaching machine. Even his work, however, predates the advent of CAI (Rath, Anderson, and Brainerd, 1959) by over four decades. Within this historical framework will be seen how many principles developed for the teaching machine were later incorporated into CAI.

It is almost certain that the original teaching machines had not the capability of teaching large groups of students simultaneously. Indeed, their designers stressed the fact that they taught on a one-to-one basis, a basis which has long

been epitomized as a model of good teaching. While these early machines provided instruction which was truly "individual", it is doubtful as to whether the instruction was ever truly "individualized".

CAI has taken up this challenge. Most CAI systems today operate using one student per computer terminal. This may be viewed as a trend within CAI which has been accepted for two basic reasons: first, the influence of the so-called "individualized" teaching machines, and second, the development of a computer technology powerful enough to permit time-sharing and hence, a terminal for each student.

Rarely has a distinction been made between the terms "individual" instruction and "individualized" instruction. This lack of clarity between two fundamentally different educational terms has been responsible for the perpetuation of at least two CAI myths: first, the assumption that "individual" and "individualized" instruction are synonymous, and second, that truly individualized instruction must be presented individually. It is suggested that neither of these assumptions is necessarily valid.

The term "individual instruction" is used to mean instruction presented to the student on an individual basis. CAI, as it is presently organized, qualifies as a system which provides individual

instruction. This is not to be confused with "individualized instruction", where the particular characteristics of the student are assessed; for example, age, intelligence, personality factors, verbal ability, socio-economic status, experiential background, and motivational level. With the characteristics of the student known, a learning experience is tailored to meet his individual needs. This is individualized instruction. By contrast, "individual instruction" is not always based on the assessed needs of the student.

Finally, it is suggested that a truly individualized program need not be presented individually. There is no reason why students sharing common needs and possessing similar backgrounds cannot be grouped together and still benefit from an individualized program.

Criticism of CAI

Dehumanization

A major criticism of CAI has also been inherited from programmed instruction. Many people feel that students interacting solely with machines will produce narrow individuals with even narrower perspectives. The argument seems to be that since humans are intrinsically worth more than machines, then human learning should be a derivative of human, not machine, teaching.

As Fitzgerald (1962) has said:

> We spend entirely too much time with machines these days. The most prominent example is watching television as a passive substitute for an active emotional life with real people . . . The difficulty is that, taken one at a time, all our interactions with machines have some value (television is educational) but the total effect in our lives is more than the sum of its parts. Interaction with, is not the same as using a machine, such as an electric drill or a vacuum cleaner, but involves being somehow part of the machine or being subjected to it . . . I find the thought of millions of children in millions of separate cubicles an appalling prospect. (pages 255-256)

While Fitzgerald was speaking primarily of teaching machines, the same criticism is often applied to CAI. If dehumanization is a threat with teaching machines, it may be even more so with the expanded potential of CAI. Hilgard (1964a) has long contended that teaching machines lead to more sedentary, restricted behaviour and this contention seems to be supported in CAI with some recent research. In a study by Feldman and Sears (1970), the academic and social behaviour of seventy-two grade one children was measured using the Child Behavior Survey Instrument (Katz, 1968). The scores on these scales describe childrens' behaviour motivated primarily by the satisfaction derived from interactions with others. They do not reflect achievement or competitive components.

Forty-five of the students were exposed to CAI in reading or in mathematics for thirty to thirty-five minutes per day over the course of a year. At the end of the year, the CAI group, who were

originally higher in social behaviour than the twenty-seven non-CAI controls, were lower in social behaviour than the control group. While absolute differences were small, the trend was significant. It appeared that the control group increased their non-academic social behaviour over the course of the year.

Disregarding the criticism of CAI being dehumanizing, its proponents have recognized clearly the potential of teaching with computers. Edwards and Scannell (1968) maintain that

> . . . digital computers may be an efficient mode for presenting instructional materials, even for large numbers of students at a time where sufficient outlets are available. (page 421)

While many of the reactions to mechanized teaching can be dismissed as being purely emotional, a legitimate criticism has come from those who suspect research in the area is far removed from the educational setting:

> Small groups of students (much smaller than a usual class) are paid well to go to a room which is not a classroom, in a building which is not a school, to do a special bit of learning in a strange way for undisclosed purposes, under the direction of a stranger so well subsidized that neither equipment nor time costs are important. In terms of social situation, motivation, setting, task, direction and resources, such undertakings are so distant from educational reality that applications from them are uncertain. (Pressey, 1964; page 365)

To some extent, computer technology has rescued CAI from this criticism. The regular use of remote terminals, data sets, and standard telephone lines, permit the installation of terminals in conventional school settings. However, technology per se has no answer as yet to the problem, if it exists, of dehumanization.

The defendants of CAI maintain that computers can do the job of lesson material presentation, and provide the reinforcement and feedback necessary for learning, in a way superior to humans. Far from being depersonalizing, the individual instruction provided by CAI permits great flexibility by allowing students to trace individual patterns through the course material (Bacon, 1969). With the added potential of individualized instruction, CAI promises not conformity of instruction, but diversity of learning - a feature highly desirable in today's educational systems (Toffler, 1970).

Rigid Interaction

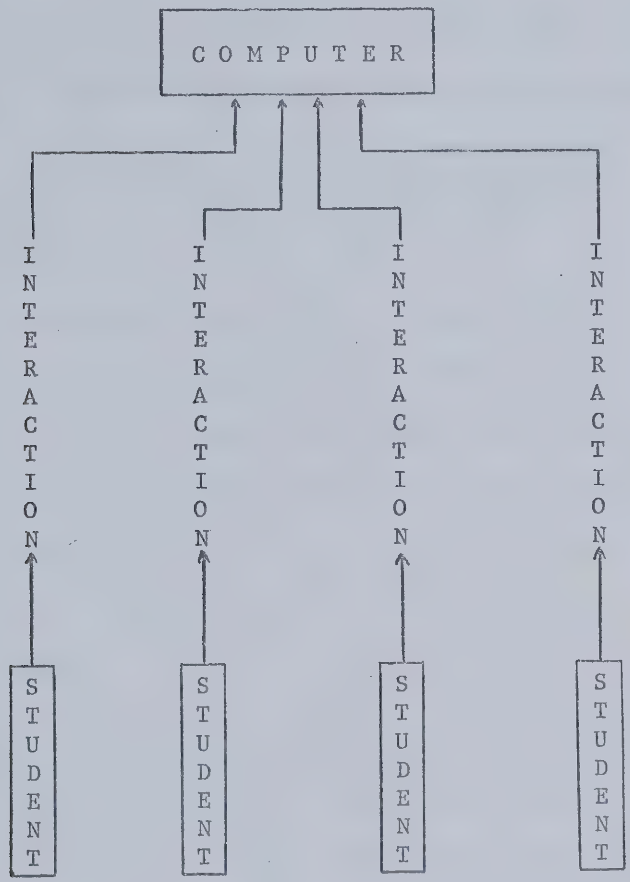
The "traditional" one-to-one student-to-terminal ratio has generally been accepted in both teaching and research with CAI. While the computer does indeed provide individual instruction for each student, the interaction between student and terminal is somewhat rigid. Attempts to reduce this rigidity and thereby

allow a "freer" interaction have been accomplished only at great expense through the development of higher level programming languages with increased costs.

The interaction is rigid in the social sense too. The student interacts only with the terminal and usually has no opportunity to discuss material with fellow students. In fact, there is an obvious absence of student-student interaction in most existing CAI settings (see figure 1). Where interaction does occur, it is often handled through the computer. This implies that the computer is capable of handling all the interaction necessary for optimal student learning and that students cannot or should not learn directly from one another. Surely, if it were admitted that students should help one another in the learning process, provision for such interaction would be made in current CAI installations. Instead, many CAI systems have students work alone in carrels or small booths, effectively and deliberately cutting off all human interaction. In part, this restriction of the learning environment is due to the expectations teachers and researchers bring with them from the traditional classroom.

Some research in CAI has pointed to the significance of learning in a social setting. Cartwright (1971), in a study of computer-assisted testing, demonstrated that students working

Conventional Computer-Assisted Instruction for Individuals



No interaction among students. Interaction exists only between student and computer

Figure 1

together were able to achieve the same amount of learning as students working alone, but with fewer computer sessions.

The rigidity of programmed instruction (PI) has been recognized as a drawback by McDonald (1965) who has suggested that

> . . . programs and other instructional strategies need to be tested on different types of students. The goal is unmistakable - to determine what strategies are effective with what pupils. (pages 98-99)

According to McKeachie (1968), one way to reduce the rigidity of PI is to utilize the expanded potential of CAI. It is pointed out, however, that while CAI provides less instructional rigidity than PI, a certain social rigidity, often in the form of social isolation, persists.

Economic Factors

While the humanists may criticize the so-called "dehumanizing effect" of current technology, it is primarily economic factors, coupled with the "inertia" of the educational system, which have stalled the implementation of CAI on a larger scale. These factors include the high initial capital cost of the computer hardware, the relatively high operating costs, and the high costs associated with authoring and revising lesson material.

It is only natural that a great deal of effort should be expended in an attempt to reduce the costs associated with CAI.

On the hardware side, much research is directed towards the production of less expensive computer terminals which incorporate such audio-visual devices as random-access slide projectors and audio units. Much of the new technology in education was originally designed for commercial or military use. Naturally, the evolution of computer technology generally, has been responsible for the great overall reduction of unit costs. For example, while the cost of the hardware has increased, the cost per unit of computer time, and the cost per student-terminal hour, has declined.

In computer software, experimentation continues with new author languages designed to effect more powerful functions in the simulation of "natural conversation" and lesson structuring, and yet take less time for authors to program. Since it is generally regarded that teachers are subject matter specialists, languages have been developed which are easy to master and take less of the teacher's time in authoring.

Cost Reduction Approach

One approach to cost reduction has been the implementation of larger central computer systems with a greater number of remote terminals. This has been regarded as one way of reducing cost on

a per student basis. The improvement of terminal hardware has brought with it lower initial costs. Since many educational grants are given on a per student basis, it becomes important to reduce costs on a per student basis. The amortized cost, or the cost of revising a CAI lesson, for example, becomes less per student if the number of students using the software and hardware is increased. Costs are spread over a larger student base. This is probably the reason why proponents of CAI are quick to point out that one of its major advantages is its ready availability at all hours of the day or night. Given present accounting methods, a longer teaching day means potentially more students taught each twenty-four hour period, with reduced operating costs per student.

Little thought has been given to reducing the cost of CAI through the group use of each computer terminal. It is partly because of the claim to individualized instruction that CAI systems have given little or no consideration to this approach. Almost all of the cost reduction approaches have been in the direction of improved hardware and computer software, with little thought given to cost reduction through improved instructional design. Yet the trend in traditional educational circles is towards group work, homogeneous grouping, and team teaching.

General Statement of Problem

This study proposes an alternative method to conventional individual CAI: that of group CAI. It is suggested that the group use of CAI will further reduce the operating costs per student, eliminate the social isolation of the users, increase the learner capacity of existing systems (see figure 2), and, at the same time, permit as good or better quality of learning in certain subject areas and with certain types of programs than exists at present. A comparison of figure 1 with figure 2 demonstrates schematically some of the essential differences between individual and group CAI systems.

Research has been undertaken to determine to what extent individual learning with CAI is affected when two, three, and four students are present at a terminal. Specifically, the following have been investigated:

1. the relationship between group size and individual learning on a CAI terminal.

2. the relationship between group size and the development of positive attitudes towards CAI.

3. the effect of certain student personality variables and group size on individual learning with CAI.

4. the relationship between group size and overall cost-effectiveness of CAI.

Group Computer-Assisted Instruction

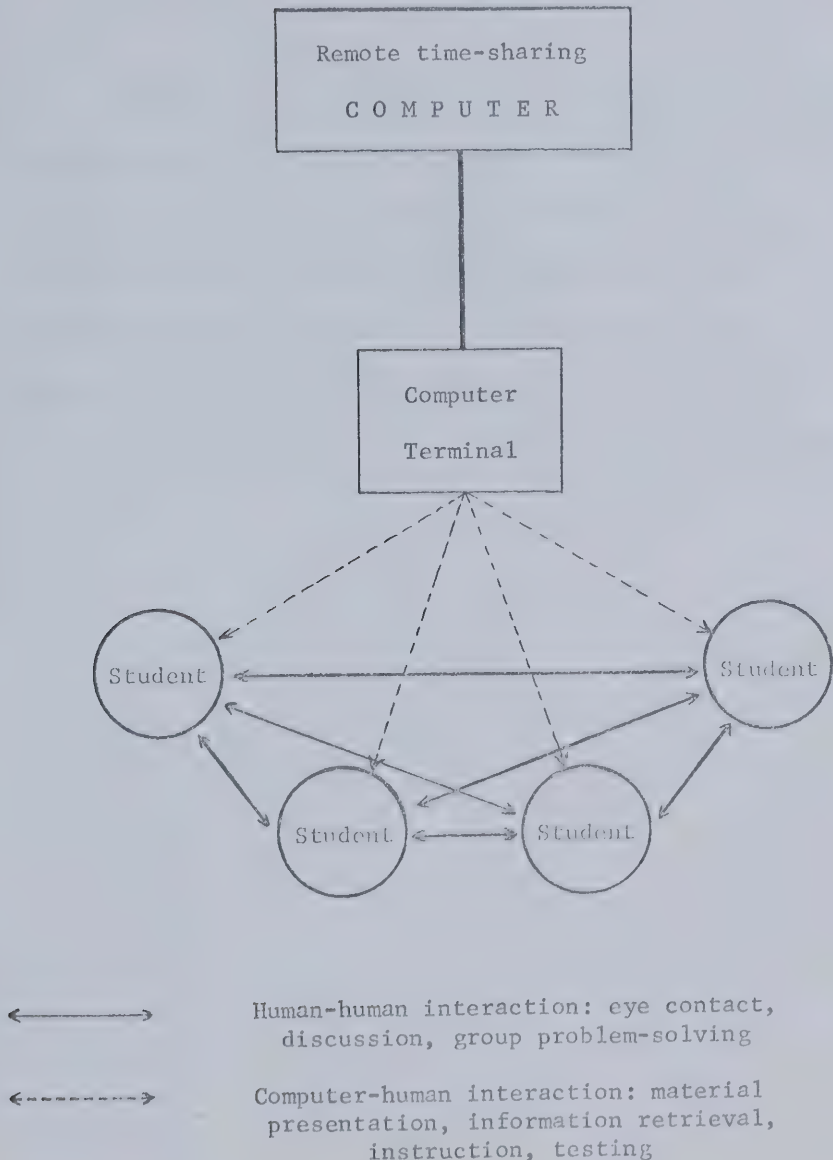


Figure 2

5. the benefits accruing to individual students through socialization at a computer terminal, from a social, educational, and economic point of view.

Taking into account the social, attitudinal, and personality characteristics of the student users, the study asks the question: "Would the group use of a computer terminal (i.e. two or more students using the terminal simultaneously) facilitate learning, improve attitudes towards CAI, benefit students with certain personality characteristics, reduce the critics' cries of "dehumanization", and reduce overall CAI costs per student?".

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The purpose of this chapter is to examine the relevant literature with respect to individuals learning in groups with CAI. Since this area of CAI has been relatively unexplored, it becomes necessary to examine other areas related to this study, such as programmed instruction and group learning. It was suggested in Chapter I that CAI incorporated many of the principles of PI. If this is so, the results of studies done in the area of group PI might well suggest the direction to be taken in designing a study of group CAI.

The first part of this chapter examines briefly the areas of programmed instruction, learning in groups, and group PI, which together provide a rationale for the study of group CAI. The second part of this chapter reviews some of the literature pertaining to the kinds of variables which have been examined in past studies, and which may be related to individual learning within a group CAI setting. These include student attitudinal and personality variables.

Programmed Instruction

While programmed instruction has been used extensively in the schools, much of the research into learning with this method has centered on laboratory investigations (Pressey, 1964; Edwards and Scannell, 1968). Relatively little seems to have been done to ascertain the effectiveness of programmed learning in actual classroom applications.

Just how well students learn with PI compared with conventional educational techniques is another area in which, according to Schramm (1964), there is insufficient research. One study by Oakes (1960) utilized a psychology program with 450 frames. While a group of thirty-six evening students learned using PI, another group learned by a "conventional" method. No significant difference in the amounts of learning was found between the two groups, suggesting that PI is at least as effective as other "conventional" methods.

One difficulty with research in both PI and CAI is that it is not generally known at what point program revision and improvement may cease, and research begin. PI and CAI both rely heavily on pre-testing, pilot studies, and lesson improvement based on student responses from actual use. When no differences are found to establish the superiority of PI techniques over "conventional"

methods, it is often claimed that the program had not been improved to its optimum level. From the studies which do exist, however, it would appear that students do learn from programmed instruction (O'Day, Kulhavy, Anderson, and Malcznski, 1971).

Learning in Groups

Background

> There is no psychology of groups which is not essentially and entirely a psychology of individuals (Allport, 1924).

While the above statement may be considered true in that all groups are composed of individuals, it is also true that there are many kinds of groups, composed for different purposes, and which operate in different ways.

A framework for conceptualizing these groups has been given by Lorge, Fox, Davitz, and Brenner (1958). They distinguish first between traditional and *ad hoc* groups. Traditioned groups function towards a goal, have knowledge of each other's resources and have established channels of communication. A team or a school staff might represent a traditioned group.

Most research must be done, however, with *ad hoc* groups assembled for an experiment for the duration of the study.

"Groupness" then, may be thought of as a continuum ranging from "just-assembled *ad hoc* groups" to well-established traditioned groups.

> Each externally designated ad hoc group therefore, in some more or less tentative way, must organize, test each other's resources, accept the task goal, muster its resources to reach that goal and then accomplish that end. (Lorge, Fox, Davitz, and Brenner, 1958; page 338)

Interaction among group members often varies and depends on the nature of the group. For example, following interaction among members, there may be individual choice without group consensus. Or, there may be no interaction among group members but open individual voting to form consensus. Finally, there may be no interaction and no consensus. In this type of group, the person works alone in the presence of others. It is often argued that the mere presence of others in this type of situation will influence individual performance. These types of groups, which are defined mainly by the socio-physical setting of the individual members, are known as "climatized" groups.

"Nominal" groups are those groups in which the members never actually come into face-to-face contact, and hence do not interact. The members all work independently of each other and are considered to be a "group" only in the sense of the statistical pooling of their results.

It is readily seen that one major problem in comparing research on groups is to define what type of group has been studied. Often results from different kinds of groups are incomparable. Hudgins (1960) makes this point, completes an experiment on ad hoc groups, and then argues that his ad hoc groups approximate traditioned groups.

Lorge, Fox, Davitz, and Brenner (1958) have recognized this problem of comparing groups with other groups and with individual performances. What should be looked at? Products of groups? Scores of the best individuals? Scores of summated individuals? All of these methods have been used and have often produced interesting but incomparable results. It may be that the research method to be used will be determined by the type of group involved and the nature of the task.

It should be stated here that the present study is concerned with the individual learning of students who have been taught by CAI, in ad hoc groups, where interaction through discussion and response by consensus, followed by reinforcement, is emphasized.

One or two other points about group study may be made before proceeding to a discussion of the results of learning in groups. The first is that research into groups is not new. The literature abounds with ancient references comparing individual and group performances. This study attempts to bridge the gap between the

classical studies of groups in learning, and the new technology of CAI.

The second point is that students themselves have long felt a compulsion towards group study. Studying in groups for purposes other than research is not new either. In a sense, the traditional classroom is a group of individuals studying together. New trends in education are emphasizing this approach: micro-teaching, team teaching, and even sensitivity groups are all variants attempting to capitalize on the group method. Indeed, Blue (1958) sees the establishment of study groups as part of the American collegiate cultural pattern. Undergraduate students

> . . . get together to 'bone up' for examinations, or to complete complex assignments. At the graduate levels, study groups are formed in which the questions for previous 'pre-lims' and the literature in the fields is reviewed. The value of 'skull sessions' is taken for granted by most of the students who participate. (Blue, 1958; page 118)

Blue has further suggested that there is a considerable lack of empirical data relating study-group activity to student academic achievement. This condition is still prevalent.

Research Studies

An early study by Barton (1926) compared two groups of students equated on age, intelligence, and sex. Barton taught

both groups algebra. The first group of eleven students worked together discussing problems, while students in the second group worked independently. Barton found that the students who worked together solved more problems correctly than did students working alone. Essentially, Barton was comparing group problem-solving with individual problem-solving.

Similar findings are reported by Klugman (1944), where fourth to sixth grade students working in pairs solved more arithmetic problems than children working separately. The paired students took significantly longer, however, to accomplish the task. Blue (1958) reports similar findings with college students. He hypothesized that group study contributed to higher grade achievement. His comparison involved one spontaneous study group and one control group of students studying independently. Both groups were equated on grade point average. It was concluded that the group study method resulted in higher grade achievement for most students, and that all but exceptional students could benefit from group study.

In a study by Perlmutter and de Montmollin (1952) it was shown that experience in group recall improved the efficiency of subsequent individual work. The study revolved around the performance of 20 groups of three students learning nonsense syllables and recalling them independently. Students in the experimental group were instructed that only the group product

was significant and members were allowed to collaborate in recalling each nonsense syllable. Later the treatments were reversed and students in the control group became the experimental group. Comparing the students who experienced the individual recall first with those who experienced the group recall first, no significant differences were found in the rate of recall. Rate of recall in this instance was defined as the total score divided by the time required for that trial. Students who participated in the group instruction first, however, demonstrated significantly greater recall than the students who participated in the individual recall first. It would appear that working in a group first facilitated later individual recall.

The authors also report that although task interest dropped more quickly, students suffered less fatigue under conditions of group recall. Groups also took more time to recall in early trials but less in later trials than did individuals. It was found too, that individuals, on the average, would invent or deform more words in recall than groups and that the group scores were better than the average individual scores. These results, which suggest that group recall is superior to individual recall, have been supported by Yuker (1955).

Perhaps there is a single strategy to recall which individuals learn when working in groups. This would account for some of the

above findings. The same may not be true however, in problem-solving situations, perhaps because each problem is unique. Hudgins (1960) hypothesized that group experience in problem-solving facilitates individual learning. He was curious to know if individual ability to solve arithmetic problems improves as a result of specifying the steps involved in arriving at a solution. Basically, Hudgins believed that disagreement among group members about a solution initiated a review process within the group. He argued that the group's function was to instruct the participants in correct problem-solving procedure. He further hypothesized that problem-solving improvement resulted from intragroup communication. His subjects were 128 fifth grade students matched on mental ability and problem-solving ability and randomly assigned to treatments. Students in the control group worked independently. The students working in groups were instructed to arrive at only one answer to the problem. Hudgins found that groups of four solved more problems than did students working alone, but that the superiority in problem-solving did not transfer to the group members working alone at a later date. He also found that having the group specify the steps in the problem-solving procedure did not contribute to the group's superiority in problem-solving.

In summary, most studies indicate that group problem-solving is superior to individual problem-solving (Hudgins, 1960; Frandsen, 1969) but there are indications that no advantages accrue to the

individual from experience in a group problem-solving situation. Problem-solving ability does not seem to be impaired, however, as a result of group experience.

Sawiris (1966b) has pointed out that all groups are not equally productive; for example, cooperative groups achieve more than competitive groups, single-sexed groups surpass mixed groups, and the intensity of participation of each group member is inversely related to the group size. He suggested it would be interesting to know to what extent success on a task can be attributed to cooperation.

Group Programmed Instruction

Background

In 1959, Sidney L. Pressey hinted that individual programmed instruction might not be the educational panacea many had hoped it would be. He maintained that while instructional programming held great potential for certain kinds of material and for certain purposes, that it needed " . . . coordination with research on student needs, knowledge and errors. And may there be a danger that learning be made too much something one attempts in a booth alone with a machine and enmeshing programmed matter; most effective learning may rather be . . . a varied, lively challenging experience with frequent interplay of minds." (Pressey, 1959; page 193)

In the same year, another leader in the field, A.A. Lumsdaine, noted:

> . . . There are many kinds of possibilities for applying mechanized and partially automated techniques in teaching, and that some of the same ideas that have given impetus to the development of individual teaching machines may readily find fruitful application in group instruction situations. This may possibly occur, in the case of many schools, well prior to the time when applications of individual machine tutoring are regarded as economically feasible and culturally acceptable. (Lumsdaine, 1959; page 152)

It is rather interesting to note that since these statements were made, little has been done to research the effectiveness of a group PI approach, with respect to students with certain social and personality characteristics. Even CAI, which has recently gained a strong foothold in education, has almost totally ignored the possibilities of group instruction, and followed the same "individualized" path as its programmed instruction ancestry.

Like so many other educational innovations, it was only a matter of time before it was realized that PI would not provide a single answer to all the ills of education. Ideally, it would be utilized as a technique in a school setting in conjunction with other established educational methods.

> . . . if autoinstruction can be brought into teamwork rather than competition with other instructional media, and if labor-saving and time-saving objective devices can be made use of, as much as they warrant, then there may be

> realization of a notable advance in methodology, greatly aiding both teacher and student . . . (Pressey, 1964; page 370)

This view is supported by Schramm (1964) who pointed out that PI is not so much revolutionary in itself as it is revolutionary in its ability to interact with other educational developments, including group study.

> More research must be directed toward the larger implication and theoretical problems of programmed instruction . . . The schools must make more imaginative application of programmed instruction, accompanied by developmental research and testing. Other channels of teaching - such as television, textbooks, films and other audio-visual means, workbooks, class teaching and group study - must be examined to see where they can beneficially apply some of the principles of programmed instruction. (Schramm, 1964; page 115)

Moore (1967) lists several advantages for group programmed instruction. In addition to student learning, these include retention of motivational and cheating control attributes, flexibility permitting competition or cooperation between or within groups, provision of feedback to the instructor from lectures and tests, and lower costs. Many of these advantages have also been cited by Hartley (1968) and Kay, Dodd, and Sime (1968).

Indeed, Hartley (1968) has hinted at a vast yet-to-be-explored area within programmed instruction:

> Actual experimentation on the composition of groups and the function and personality of the members has not been done, and it would appear

> at the moment that this basic aspect of group programmed learning has yet to be pursued. (page 209)

This applies equally well to computer-assisted instruction. Nevertheless, while Hartley suggested the opening up of new research areas to determine the effect of student characteristics on learning in a group PI situation, an even stronger case was put by Kay, Dodd, and Sime (1968) who maintained that when a program has been improved to its optimum level, it may very well be a suitable device for group instruction.

> If a programme is made as efficient a teaching instrument as it can be by initial planning and subsequent evaluation, then we have such a successful technique for controlling student behaviour that we could teach a group together. (page 129)

One question which comes to mind is: "Would the performance of individuals working in groups equal or surpass the performance of those working individually?" Hartley maintains that there may be instances where learning alone may not be as effective as working in pairs or in small groups. The issue has yet to be decided by further research, but it is likely that whatever results emerge from studies of group PI, they will have some application in group CAI.

Research Studies

A number of studies have been carried out in group PI. Farber (1965) studied single-sexed groups working with a 161

frame, single lesson program. A control group took the criterion test but not the program. Two experimental groups received individual reinforcement and a third experimental group received reinforcement as a team. Students were equated on intelligence and reading scores. In all 132 eighth grade pupils working in groups of four, participated in the study.

Farber found that all the experimental groups performed better than did the control group, and that performance did not diminish with lack of reinforcement. Boys in the study generally scored higher than girls. In a test of retention, it was found that subjects who received individual rather than group reinforcement, excelled.

Methods of presentation vary from study to study. Farber had one member of each group act as a "reader" to read the frame to the group. A study by Sawiris (1966c) used filmstrip to project a linear geometry program to a group of students, several frames at a time. In terms of group size, the author concluded that a group of eight students is optimum. Groups of sixteen took more time overall, but the scores of individuals, groups of eight, and groups of sixteen, varied little. Each student was allowed to formulate his own response and to help his fellow students. It is pointed out that helping one another is one way of minimizing individual differences.

Frandsen (1969) had groups of three students work on a Pressey-type trial-and-check teaching machine on the "Principles of Learning in Teaching". He found that teams consistently answered more questions correctly than did individuals, and that practice is necessary for effective teamwork. Experience in teamwork, however, did not improve subsequent individual performance on the tests. This supports the findings of Hudgins (1960).

Kay, Dodd, and Sime (1968) have proposed a variation of group-paced instruction. In their study, material was projected via 35mm film to a large class of students, each of whom responded on his own console. The decision to move ahead to the next frame was reached when a certain percentage of responses were in, based on a normal distribution in time for each item. While it was conceded that in fact responses were not normally distributed in time, initial results indicated the process to be satisfactory in terms of individual learning. The authors argued that since the teacher decides what is taught, and how, and what constitutes an acceptable criterion of learning, that he should not stop short of also deciding the pacing. Their system shares many similarities with the systems proposed earlier by Moore (1967) and Frye (1963).

In a review of the literature on PI in pairs, Hartley and Cook (1967) concluded that there is little evidence as yet to suggest that learning in pairs is superior to that of individuals

using PI. There is no evidence, however, to suggest that the pairing of students, or the grouping of students, is in any way detrimental to the learning process. There is some evidence to suggest that the rate of progress of a group of children working together may be determined partially by groupings (Hartley, 1966).

Finally, it must be pointed out that much of the research in PI with groups has used programs written for individuals. It may be that programs designed especially for groups might improve the learning of individuals in groups. More meaningful results then, might be obtained by comparing learning performance using group programs with learning performance using individual programs. There is a possibility too, that savings in programming time and cost could be effected if it were discovered that groups are able to assimilate, through group discussion, larger "chunks" of information. Such areas of research, however, must await the results of studies dealing with the characteristics of the student users. It is an unfortunate fact that, in Hartley's (1966) words, the student is always "external" to the machine and that past research has concentrated on the hardware and software and not the student. It is as if the students were uninvolved in the learning process. Hartley believes that only with greater control over, or allowance for the social factors, will come greater control over the learning process.

The Absence of Self-Pacing

One major difference between group and individual programmed instruction is the kind of pacing the student experiences throughout the program. Whereas under individual PI the student is encouraged to work at his own pace, working in a group setting brings with it group pacing. The student must try to match the pace of the group. To those who extol the virtues of individual pacing, the idea of group work under group-paced conditions would seem to cancel any advantages programmed instruction might offer. This is hardly the case however. Other features of PI are in fact maintained in group-paced learning. The trend in research on group PI is to demonstrate that the principles of individual instruction and individual pacing are not necessarily basic nor essential for learning to occur. Certain advantages of group PI begin to emerge: a wider audience can be reached simultaneously, and lesser administrative difficulties arise as a result of group pacing. For example, students on a group-paced system tend to finish programs more closely together (Hartley, 1968). This is often convenient administratively. As Lumsdaine (1959) has pointed out:

> Despite the unquestioned potential advantage of this individual pacing, (with individual teaching machines) it is to be noted that some group instruction techniques can offer many of the advantages of individual teaching machines (e.g. controlled sequencing, prior programming, provision for active response, correction-feedback, etc.). Also, they may in some instances have economic

> and other features that make them easier to introduce into current educational situations. (pages 148-149)

It has been suggested that a student's own pace is not necessarily his best pace (Gropper and Kress, 1965; Moore, 1967). Very often, fast-paced students produce more errors, while slow-paced students are less economical in terms of time. It is doubtful to what extent individualization, if indeed self-pacing is an important component of individualization, depends on self-pacing.

The arguments against individual pacing do not necessarily favour group pacing. Kay, Dodd, and Sime have experimented with methods of external pacing. They believe that time is an effective measure of control and that "it is wasteful to go to such lengths to control behaviour and then permit students to respond as they wish" in terms of time (pages 129-132). The authors argue that self-pacing seldom has a counterpart in the real world. People ask a question and want an answer on the spot. Often, tasks once given, must be carried out immediately. Seldom does the nature of the real world allow us to be "self-paced".

A research study by Sawiris (1966c) has demonstrated that some forms of group learning achieve results comparable to individual self-paced instruction. He used groups of two and eight students and found that they learned well from projected

materials provided they had adequate time to respond.

Hartley (1968) concluded that, despite the limited nature of the evidence, there are " . . . conditions where learning under conditions of self-pacing may be less efficient than learning with others and/or under some form of external pacing" (page 206).

Group Computer-Assisted Instruction

The arguments in favour of group CAI parallel those made for the establishment of group PI. Essentially these are:

1. That students can and should learn from one another as well as the computer.
2. That the group use of the computer represents a more "human" use of the technology.
3. That group CAI may win more rapid acceptance in educational communities than individual CAI.
4. That students learn equally well with group CAI.
5. That group CAI can effect a significant cost reduction in terms of equipment and operating costs per student.

In addition, group CAI may be implemented as an additional alternative to individual CAI in the belief that students with certain personality and social characteristics may develop more positive attitudes towards CAI generally, and improve their overall

learning performance.

As Blue (1958) pointed out:

> There is a very great need to examine critically the student and the whole context in which his learning takes place . . . The question of whether it is more beneficial to study alone or in collaboration with other students still warrants investigation. (page 118)

This question has relevance today, and it is suggested that to examine the context in which students learn through CAI would not be an unprofitable exercise.

Goodman (1968), in a study of attitudes towards CAI, compared team study with individual study using programs in economics, home economics, and geography. He reported a possible advantage to using team study followed by individual study in CAI to effect positive changes in both attitude toward CAI and learning performance.

The complexity of CAI has been recognized by Hess (1970):

> . . . a view of the computer as a dispenser of information is simplistic and distorted. It fails to indicate the extent to which CAI involves the student in interaction which has affective and social overtones in addition to its instructional function. This interaction, and the ways it might be varied in future programs, have potential effects not only upon <u>what</u> a child learns but also upon the processes through which he relates himself to the structures, both technological and human, of a complex society. (page 102)

With its inevitable expansion, the influence of CAI as a sociological phenomenon may far outstrip in importance its instructional impact. If studies such as Feldman's (1970) which suggest that the extensive use of CAI may lead to less social behaviour, are correct, then it may well be that such systems as group CAI, which heighten social interaction, will be increasingly called upon.

Hickey (1968) has called the expansion of CAI inevitable due to the trend to individualized instruction, the rapid growth of information, and the shortage of qualified teachers. The importance of such alternative systems as group CAI may very well increase in direct proportion to the expansion of CAI generally.

Love (1969) reported a study in which paired students' performance on an abstract algebra program presented by computer was compared with that of students working independently. The paired students were allowed to choose their own partners. Love believed that choosing a partner would allow the formation of a pair most closely approximating a traditioned rather than an *ad hoc* group, and that traditioned groups are superior to *ad hoc* groups in performance. An IBM 1500 CAI system was used to present five 40-minute linear programs in Boolean Algebra to senior high school students. Eighteen students worked individually and

thirty-six students worked in pairs. Both pairs and individuals obtained the same levels of performance on the final examination. Similar findings were reported earlier by Grubb (1965). Grubb compared the learning performance of ten individuals with that of ten pairs of college students learning statistics by CAI. The paired students in this case, were not able to choose their own partners, but were assigned to pairs on the basis of CEEB verbal scores. High students were matched with other high students, and low students with low students. No significant differences in performance on the final examination were found for any of the treatments.

Finally, cost factors enter the picture. The potential cost reduction achieved by using groups of students at a terminal could be phenomenal. Simply by pairing students, costs may be reduced as much as fifty percent (Love, 1969). A group of four students might effect a cost reduction of seventy-five percent. Since the number of terminal hours are reduced by a similar percentage, the hardware is freed for other use. Comparing two groups of four students, one group taught by group CAI, the other by individual CAI, savings could materialize in:

1. terminal and other hardware usage
2. maintenance and repair costs.
3. computer processing (CPU) time.
4. terminal connection time.

These are absolute cost reductions, which may be translated into costs per student. Since many educational grants, especially those from governments, are calculated on a cost per student basis, the cost of CAI per student becomes increasingly important.

First, the amortized cost per student is reduced, assuming more students use the system under the group CAI method.

Second, the software cost per student including the cost of computer programming and lesson revision is similarly reduced, with increased numbers of students. In effect, the provision of group CAI enables the overall cost of CAI to be spread over a wider student base. In this way, more CAI work can be undertaken with existing government grants calculated on a per student basis.

Finally, the overall lower cost of group CAI is independent of cost reduction achieved by technological improvements. This may well have the effect of making CAI more attractive to potential educational markets such as school systems, and ultimately further the general aims of CAI. Researchers in the areas PI and CAI have not been slow to recognize the cost benefits of group instruction (Lumsdaine, 1959; Frye, 1963; Moore, 1967; Hartley, 1969; Kay, Dodd, and Sime, 1969; Goodman, 1968; Love, 1969).

Personality Variables in Learning

Eysenck (1971a) has pointed to the importance of personality variables in studies of academic attainment:

> For decades, psychologists investigating educational problems and making predictions of academic success or failure have concentrated on cognitive measures; yet personality factors, particularly extraversion and neuroticism, are obviously responsible for a good part of the total variance. (page 3)

A number of studies have shown that extraversion tends to be a negative indicator of high academic attainment at most levels (Eysenck, 1971a). A study of engineering students by Furneaux (1962) examined the effects of extraversion and neuroticism on university failure rates. It was found that students classified as low neurotic-low introvert (stable extravert) had a failure rate of 61%, while students classified as high neurotic-high introvert had a failure rate of only 21%. Similar findings had been reported previously by Lynn (1959) who demonstrated with a group of several hundred university students, that good educational attainers tend to score high on neuroticism and low on extraversion.

Savage (1962), in a study of 168 Australian students entering university, reported that high scores on both neuroticism and extraversion tend to depress academic performance. While his study supported the findings of Furneaux (1962) and Lynn (1959) with respect to extraversion, his findings with respect to neuroticism,

which disagreed with the results of Furneaux and Lynn, led him to conclude that the relationship between neuroticism and achievement may not be a linear one. Indeed, Eysenck (1971a) too, has conceded that the " . . . role of neuroticism is somewhat ambiguous - it may act as a drive, and thus aid in good performance, or it may interfere with performance, and thus be a debility" (page 3). Savage's work has been supported in part by the work of Child (1964) who found that among 178 children from comprehensive and public schools, introversion is positively related to attainment. He concluded that students least able to cope with examinations usually tend to be neurotic-extraverts, while those most able to cope with examinations tend to be stable-introverts.

In a study by Amaria and Leith (1969), it was demonstrated that the best individual performances in PI came from anxious introverts or high-ability extraverts. When students worked in pairs, the best paired performances came from either anxious extraverts paired with non-anxious introverts (both of high ability) or high-ability anxious extraverts paired with low ability non-anxious introverts. A more recent study by Spielberger, O'Neill, and Hansen (1970) lends support to the theory that performance in CAI is related to the subject's anxiety-state.

Guilford's Social Introversion-Extraversion was used as a measure of sociability in a study by Beach (1960) involving four types of learning situations. Subjects were randomly assigned to

learn by lecture, group discussion, autonomous small groups, or independent study. Beach hypothesized that more sociable students would attain more in interactive social situations. He did in fact find that less sociable students learned more in lectures and that more sociable students learned more in the autonomous small groups. Contrary to his prediction, however, the less sociable students also did well under the group discussion method. Among students who studied independently, there were no significant differences in learning between high and low social students.

In terms of performance, Eysenck (1971b) has suggested that individuals with low arousal levels (the extraverts) show greater immediate reminiscence than do the introverts. Introverts conversely, show greater memory under delayed conditions.

Several student characteristics relating to programmed instruction have been examined by Doty and Doty (1964). These were need for achievement as measured by Edward's Personal Preference Schedule, social need as measured by the Guilford-Zimmerman Temperament Sociability scale, creativity as measured by Getzel and Jackson's Four Tests of Creativity, and academic achievement as measured by grade point average. Fifty male and fifty female college sophomores entered a course of two week duration consisting of 1507 frames of physiological psychology. At the end of the course, each student completed a seventy-five question multiple-choice examination. It was found that achievement

on the criterion test was significantly related to grade point average and social need for the total group and for sex. When the grade point average was controlled statistically, there still existed a significant correlation between achievement and social need for all comparisons. This correlation was negative in direction; the higher the achievement, the lower the sociability score. Negative relationships were also found between achievement and creativity scores, but these were significant only for the total group ($r=-0.43$; $p<.01$, $N=100$). This was interpreted as giving support to the view that certain types of programmed instruction may inhibit the creative thinker.

No significant correlation was found between achievement need and PI effectiveness. It would appear that PI does not relate to achievement need as do other forms of instruction. Neither were there significant correlation coefficients between achievement and student attitudes toward programmed instruction.

It was concluded that the effectiveness of programmed instruction was related to certain student personality variables. High test scores tended to originate from students with low social needs, and high academic ability.

> One highly touted aspect of the programmed approach is the fact that the learning situation is essentially a solitary one in which each student proceeds independently. Presumably, learning is facilitated by the elimination of interference from individual differences in speed, from competition among students

> of unequal academic ability, and from social factors such as teacher-student interactions and classroom atmosphere. However, the present results indicate that these characteristics of programmed learning may be deterrents for students characterized by high sociability needs. (Doty and Doty, 1964; pages 336-337)

A study by Lublin (1965) pointed out the uncertainty of the relationship between scholastic aptitude and achievement in programmed courses. She cites seven studies, three of which found no relationship and four which did. Her own study at Pennsylvania State University examined the effect of autonomy scores of 219 students on performance in a programmed psychology course. The results of this study differ from those of Doty and Doty. It was found that high autonomy subjects were significantly poorer on the criterion test than were the low autonomy students. This direction was unexpected. Lublin explains, however, that this unexpected direction may have been caused by the design of the experiment. Highly autonomous students were frustrated since they had to come to class, make up missed work, complete material handed to them by the experimenter, and return all material at the end of the session. This might explain the low score. Low autonomous students, however, felt comfortable in this atmosphere and as a result produced high scores. What is not known is the relationship between the autonomy variable in the Lublin study and the social need variable in the Doty and Doty study. This makes the two studies only minimally comparable but it may be

concluded that variables of this type can and do systematically influence learning performance. The question is, "How can personality differences among students be capitalized upon to effect optimal learning?" As Edwards and Scannell have pointed out:

> Statements that programmed instruction allows students to work independently at their own rates avoiding competitions and pressure, may have greater significance than was previously known. Some of these "virtues" may be deterrents in terms of achievement by students with certain psychological needs. Utilization and effectiveness of the method may need to be considered in other contexts than the ones most often proposed. Indeed some 'non-significant results' and apparent failures may call for interpretation in other ways. (Edwards and Scannell, 1968 page 411)

Student Attitudes

It seems natural to expect that the attitude a student has towards a method of learning will have some influence on his learning performance. In the study by Doty and Doty (1964), high-achieving females showed a favourable attitude towards PI while the men in the study showed a negative but non-significant relationship between attitude towards, and achievement in, programmed instruction. Bundy (1968) too, has pointed out that the student's attitudes toward CAI are directly related to personal performance. He adds that "students often feel the need for shorter sessions with more discussion and teacher interaction" (page 425).

Newsom (1969) suggested that motivation for more experimentation and use of educational technology will probably stem from the attitudes of students towards their technological teachers. He reported that students often "personalize their mechanical teacher", bidding it 'hello' and 'goodbye' at the opening and close of each session. When questioned, students often replied, "I like this teacher because he likes me" or "I like him because he doesn't know I'm black" (pages 142-143).

Experience with any new technology is likely to change one's attitudes towards it. Mathis, Smith, and Hansen (1970) concluded that most students, especially after experiencing CAI, developed familiarity with the material to be presented by CAI also encouraged positive attitudes. Although their study was conducted with students working on IBM 1050 terminals in "small booths", they reported that none of the students felt isolated or bored. One might suspect that the novelty of the system would account for the lack of boredom initially, as well as the lessened feelings of isolation. Hartley (1966) has pointed out that favourable student attitudes are often produced by short PI courses rather than long ones. He also suggested that students prefer to be taught by a combination of lecture and machine rather than by machine alone. In a study of computer instructed learning, Goodman (1968) maintained that attitudes towards CAI may be modified by particular programs and

systems. He found that most of his subjects had favourable attitudes towards CAI and that most approved of teamwork in CAI. Students in Love's (1969) experiment also tended to exhibit positive attitudes towards CAI. They felt the benefit of working with CAI in pairs was that the partner could help out in time of difficulty. The most undesirable feature of working in teams, according to the students, was that the partner either disagreed too often, or moved through the program too slowly.

Finally, a major study of attitudes was conducted by Hess (1970). His study was concerned with low socio-economic status junior high school students, working with CAI on teletype terminals. He found that since the computer is evaluative only in specified learning tasks, and not in such areas as discipline, and that since the computer possesses human-like qualities giving it "charisma" (usually by greeting students by name) that students soon developed more positive attitudes towards the computer than towards their human teacher. Hess maintained that CAI is capable of generating positive attitudes which may transfer to other real-life situations. In his study of attitudes, one sees immediate advantages of CAI in the education of disadvantaged children.

The present study will concern itself with discovering if working in a group can heighten these positive attitudes towards CAI to make it a more effective teaching system.

The Time Variable

A number of studies have made reference to whether or not groups excel in terms of time in PI and CAI. In an early study of problem-solving, Klugman (1944) found that while groups solved more problems than did individuals, they took proportionally more time to do so. He attributed this to the presentation, discussion, rejection, and acceptance of a greater number of possible answers which occurred when children worked together.

In an effort to compare group-pacing versus individual pacing in PI, Frye (1963) studied groups and individuals working through a linear program. He found that time differences in performance were related to the degree of heterogeneity of the group with respect to classification on the Orleans Algebra Prognosis and the Primary Mental Abilities test.

In two studies of pairs versus individuals working with CAI, no differences in time were found (Grubb, 1965; Love, 1969). Several studies in programmed instruction indicated that groups are able to work through a program with a significant saving in time over individuals (Stones, 1966; Moore, 1967).

Since the present study proposes the group use of CAI with its attendant economic advantages, it is important to know how groups moving through a program compare with individuals in the

same program. It might be that groups increase the terminal connection time by exploring interesting paths in branching programs, or by overly long discussion of the material. With the facility for accurate time-keeping built into CAI systems, it should be possible to discover if, in fact, groups do move through each lesson as quickly as individuals.

Summary of Chapter

This chapter presented a review of the literature in the areas related to this study. These included PI, group learning and problem-solving, and group PI and CAI. Some consideration was given to the relationships between student personality and attitudes, and learning. In addition, studies which examined student performance over time were reviewed.

CHAPTER III

STATEMENT OF THE PROBLEM AND RESEARCH DESIGN

Statement of the Problem

The central question in this study is "Can CAI be used to teach varying sized groups as effectively as it can teach individuals?" If it can, then it might be worthwhile to know how personality, attitudinal, and social variables relate to learning in a group CAI setting. It might be that these variables can be manipulated so as to optimize the learning performance of students, either by assigning students with particular personality characteristics to certain groups, or by making provision for those characteristics within the CAI program.

Learning Performance

Since the primary question is essentially one of learning, Hypothesis 1 was formulated to test whether or not individual learning is facilitated by CAI teaching groups of students.

Hypothesis 1

> The learning performance of students taught in groups by CAI is equal to or better than the learning performance of students taught individually by CAI.

It was predicted that the learning performance of students taught in groups of two, three, or four, would equal or excel the learning performance of students taught individually. It is suggested that groups of students working together have a higher probability of converging on a correct response than do individuals working independently (Love, 1969), and that this is true whether the response is of the multiple-choice or freely-constructed variety. The tendency to produce fewer response errors increases the amount of positive reinforcement through knowledge of correct results (KCR) which, in turn, is amplified by social reinforcement within the group. It is argued that this process will increase the probability of superior learning performance for each individual group member.

To test this hypothesis, four treatment groups were established which used CAI as the instructional medium. These four treatments consisted of a control group which worked on three CAI lessons individually, and three experimental groups which worked on the same lessons in pairs, groups of three and groups of four. In all cases, the students' individual learning performances were examined.

Attitude Change and Learning Performance

It was hypothesized that direct experience with CAI would change an individual's attitude towards CAI as a teaching method. In other words, attitudes would be less dependent upon minimal knowledge and preconceived notions of CAI, and more upon first hand experience. It was believed that students working in groups would tend to perceive the terminal as less of a threat and would be more open to seeing its advantages as a teaching system.

Further in the formation of attitudes toward CAI, it was thought that if operating difficulties should occur with the terminal due to malfunction or initial lack of user experience, a student in a group setting could readily call on a fellow group member for assistance. A student working with CAI individually, however, would be more likely to feel frustration when difficulties arise, and this frustration would likely be displayed in his attitude towards CAI as a teaching method.

Hypothesis 2 was designed to test whether there were any significant attitude changes between students working in groups with CAI and students working individually with CAI.

Hypothesis 2

> After exposure to CAI, students taught by the group CAI method will tend to exhibit

> more positive attitudes towards CAI than
> will those students taught individually
> by CAI.

Implicit in this study of attitudes toward CAI was the belief that positive regard for CAI contributes to enhanced learning performance.

Personality Variables

Students who work individually with CAI concentrate on learning the material presented by the computer. Traditionally, most CAI systems have centered on providing for individual differences in learning, and minimized or ignored individual differences in personality (Hansen, 1969). The fact that very little variance in learning has been accounted for by personality factors in the past, has led CAI proponents along the path of improving instructional strategies to optimize learning.

It is suggested, however, that with CAI teaching groups of students, more variance in learning may be accounted for by personality factors. Since the essence of group CAI is learning from others as well as from the computer, such events as incompatible personality characteristics of students in groups may well counter the overall advantage to learning performance.

It might be important to know if the presence of certain

personality characteristics can enhance individual learning performance in a group CAI situation. It is pointed out that the group CAI method is not intended as a replacement for individual CAI. Some students with particular personality orientations may work better in groups, others may excel working alone. If group work in CAI can be shown to be a legitimate alternative to individual CAI, then this provides educators with a choice of CAI methods to optimize student performance, based on the characteristics of the student.

In terms of preference, some students might prefer to work alone at a CAI terminal, while others may prefer group work. This might well be associated with the tendency to be attracted to, or to avoid, participation in social situations. It is suggested that such tendencies may be reflected along a dimension of introversion-extraversion.

Hypothesis 3 was designed to compare differences in learning performance among students classified along this dimension.

Hypothesis 3

> The learning performance of extraverts working in groups is superior to the learning performance of extraverts working independently.

It was predicted that students classified as extraverts will

tend to learn more in a CAI group setting, while introverted students may be expected to learn more working alone.

Neuroticism-stability is another dimension along which students can be classified. It is suggested that when working individually, learning performance may be affected only minimally by the student's degree of neuroticism. When working in small groups, however, the student's degree of neuroticism may substantially interfere with effective learning.

Hypothesis 4 was formulated to test whether students classified along a dimension of neuroticism-stability exhibit differences in learning performance when taught by CAI in groups rather than individually.

Hypothesis 4

> The less neurotic an individual, the more likely his tendency to produce superior learning performance in a group CAI situation.

It was predicted that the more neurotic a student is, the less he is able to interact successfully and, hence, learn from others. Highly neurotic students, then, were expected to learn more by working alone at the CAI terminal. Stable students were expected to do well in either the individual or the group CAI setting.

It is noted that there may be some interaction between the

dimensions of introversion-extraversion and neuroticism-stability. In this event, it is still possible to conceive of personality types best able to profit from one or the other method of instruction. It is probable that, according to Hypotheses 3 and 4, the group method of instruction would benefit the neurotic-introvert least, and the stable-extravert most.

One other dimension was chosen along which to classify students. This was a scale of perceived behavioural control: internal versus external locus of control (Rotter, 1966; 1971). Students classified as "external" are those who tend to reject responsibility for their own actions. Usually, they tend to believe in fate, chance, or luck. Students classified as "internal", however, accept responsibility for their actions and tend to perceive themselves as masters of their own destinies. They perceive success to be contingent on their own actions.

If the internal students perceive success as contingent on their personal decisions, then it is likely that in CAI, reinforcement is more effective for the "internals" than for the "externals". The implicit reaction of the "internal" student would be one of "The machine is rewarding me for a choice I made", whereas the "external" student would tend not to see reinforcement as being contingent on his choice of response. It would appear that the effect of reinforcement under these conditions would differentially affect learning.

Hypothesis 5 was designed to test under what conditions, group or individual, "externals" may be expected to demonstrate superior performance in learning.

Hypothesis 5

> Under group CAI conditions, students classified as "external" are more likely than students classified as "internal" to show superior learning performance.

Cost Factors

It has already been suggested in Chapter II that the amount of computer time used per student can be reduced as a function of the size of the group of which he is a member. With a group of four students, the cost of presenting a lesson may be divided among the four students. This means that the average cost per student is reduced 75% over the cost of providing the lesson individually, assuming equal operating costs per execution under both conditions.

It is not certain, however, if the time taken to complete a lesson in a group is the same as if the lesson were taken individually. Neither is it known if the execution costs for both methods are equivalent. There are many reasons to suppose that there are differences. First, the discussion of lesson material by the group members may significantly increase the time spent to

complete the lesson and hence increase terminal connection costs. Second, group members may wish to explore various branches within the program and thereby increase execution (CPU) costs. It must be pointed out however, that probably none of these cost increases would ever be so great as to offset the economic advantages group instruction might have over individual instruction in CAI.

One of the benefits of using a CAI system is its accurate time-keeping capability. This study proposed to examine the average time taken to complete each CAI lesson for individuals, pairs, and groups of three and four. The measure, known as "elapsed time", indicated the amount of time taken from the execution of the first computer statement in the lesson, to the last statement, exclusive of sign-on, compile, or load time for the program.

Hypothesis 6 was designed, utilizing this measure of elapsed time, to test for differences between individuals and groups taught by CAI.

Hypothesis 6

> There is no difference between individuals and groups in the amount of time taken to complete lessons presented by CAI.

Subjects

Subjects were drawn from over 300 summer school students, most of whom had at least one undergraduate degree, and all of whom had been employed as teachers in various schools the previous year. Because of lack of teacher certification, each student was required by the Quebec Department of Education to pursue a three summer session sequence in education at McGill University. Each of the summer sessions is five weeks long and students take a number of courses each summer. Part of their work during their first summer was to complete the introductory course in educational psychology, Education 501, taught by the author.

Subjects ranged in age from 20 to 59, with the average age being in the late twenties. Educational background of the subjects ranged from two years of university to completion of the Ph.D degree, the modal educational level being the possession of a bachelor's degree.

Since the summer of 1971 was their first as education students, most had very little knowledge of such educational techniques as computer-assisted instruction.

Research Design

Students from four lecture sections of the course were pooled

and those students with background in psychology were screened out. The remaining students, without previous background in psychology, were assigned randomly to one of four treatment conditions. This design assumed that students in the experimental group would have virtually zero knowledge of the subject matter to be learned, and eliminated the necessity of a pretest of learning.

The treatment conditions were identical except for group size, which ranged from one to four students per terminal. Those students who worked individually at a terminal (individual CAI) were designated the control group.

The random assignment of students to these four treatment conditions helped assure the effects of such confounding variables as typing ability, intelligence, or computer terminal experience would be equivalent for all treatment groups.

Those students who had declared themselves to be knowledgeable in the area of psychology were permitted to take part in the study. They were, however, assigned to their own set of four treatments.

All the treatment groups used the same CAI terminals, took the same three lessons, and responded individually to the same criterion learning test. Groups were instructed to take each lesson one week apart, and to write the criterion test one week after the final lesson. This helped ensure equal time intervals between sessions for all groups.

Randomization

On entering the course, each student was presented with a card containing a six digit number. The cards had been arranged randomly previous to the commencement of the course.

Students with any background in psychology, particularly in the areas relevant to the subject matter in the CAI lessons, were encouraged to take a special card. They were told that this was simply for grouping purposes and would not entail any extra work or a different evaluation.

If there was any doubt as to whether the student was knowledgeable in the area, he was advised to declare himself knowledgeable. This helped ensure the experimental and control groups had minimal knowledge in the subject area. About 10% of the students declared themselves to be knowledgeable and were assigned to a separate set of four treatments on a random basis.

The entire randomization procedure was completed on the first day of the course, students contacted their fellow group members on the second day, and the CAI lessons began on the third day. Such a restricted schedule and rapid randomization procedure was necessary in order that all the groups could complete the study in the time available.

The number of students who completed the course and for whom a complete set of data is available is given in table 1:

TABLE 1

TOTAL NUMBER OF STUDENTS YIELDING COMPLETE DATA

Category	Group Treatment 1	2	3	4	Total
No background knowledge	78	61	80	63	282
Some background knowledge	6	10	3	8	27
Total Students					309

Procedure

Students were permitted to decide within their respective groups which day of the week they would prefer to take the first CAI lesson. It was mandatory, however, to take the remaining lessons and the criterion test on that same day each week thereafter. Only in cases of absences did this procedure vary. Groups were not permitted to complete a lesson when a fellow group member was absent. The group was instructed to wait until his return and to take the lesson together. Rarely did this mean postponement of more than one day.

Subjects in the control group worked individually and were instructed not to interact with others during the CAI lesson. Subjects in groups 2, 3 and 4 worked in groups of that size and

were encouraged at the beginning of each lesson to discuss the material and converge upon a single response. The group was asked to designate one member to respond on the terminal. Groups larger than four were ruled out, due to the difficulty in seating a large number around each terminal, and the difficulty in reading the printed material. It was believed, too, that an optimal group size probably exists and that groups larger than four around a standard terminal would exceed the optimum number of members.

TABLE 2

TIMETABLE OF THE EXPERIMENT

1971 Date	Day Number	Activity
July 5	1	Assignment of Student I.D.'s and random assignment to control and experimental groups.
July 6	2	Groups informed of fellow members. Completion of Teaching Methods Questionnaire II - pretest.
	3	a.m. -Instruction given on computer terminal operation
		First reservations for terminal use accepted.
		Installation of telephone lines, acoustic couplers and computer terminals.
		p.m. -First CAI lessons begin
July 7 - 13	3-7	Designated WEEK 1
		CAI Lesson 1 - The Nervous System: Pathways in Learning and Perception.
July 14-20	8-12	Designated WEEK 2
		CAI Lesson 2 - Modes of Sensory Control: Higher and Lower Behaviour.
July 15	9	Completion of Survey of Educational Opinions
July 21-27	13-17	Designated WEEK 3
		CAI Lesson 3 - Sensory Stimulation, Arousal and Motivation.
July 28-August 4	18-22	Designated WEEK 4
		Session 4 - Each student completes individually: 1. 30 item learning criterion test 2. Internal-external locus of control scale 3. Seven item information questionnaire
July 29	19	Completion of Teaching Methods Questionnaire II - post test.
August 6	25	Final Course exam - unrelated to this study.

The above timetable assumes 25 working days within a five-week period, from July 5 to August 6, 1971.

Description of the Measuring Instruments

The Survey of Educational Opinions

The Survey of Educational Opinions (McLeish, 1970) is an instrument containing scales compiled from a number of sources and yields scores on thirty-one personality dimensions. While only three of the scales are of immediate use in the present study as covariates of successful learning in group computer-assisted instruction, it was hoped that the collection of data on the remaining 29 scales could form part of a larger and ongoing study.

The Survey was administered to all of the subjects during the course of the study and was completed as part of a course assignment. Subjects responded by filling in three specially over-printed answer sheets which later could be optically scored. A copy of the complete Survey is to be found in Appendix 1. The three scales, anxiety, introversion-extraversion, and neuroticism-stability, which are of importance to the present study, are further described below.

Anxiety

The questionnaire dealing with anxiety was originally the Crown Word Connection List (McLeish, 1970), which discriminates between the types of responses usually made by normal and neurotic

populations. Subjects are given a word and asked to associate with it one of two other words. For example:

	A	B
HEAVY	weight	heart
NEEDLE	drug	sharp

Underlining "heart" and "drug" would be indicative of anxiety. An anxious subject will tend to choose a word that represents a particular anxiety or worry to him. There are 50 such items in the Word Connection List.

There is some evidence that this test can differentiate between criminal psychopaths, neurotics, teachers, nurses, soldiers, and other kinds of normal and abnormal populations. In a sample of American students, the test was found to correlate with Eysenck's Neuroticism 0.412, and with Cattell's 16 Personality Factor test as follows:

Factor C (stability) - 0.247

Factor E (assertive) 0.261;

Factor G (conscientious) - 0.265;

Factor L (suspicious) 0.372;

Factor M (imagination) 0.235;

Factor O (apprehensive) 0.341;

and with

Factor Q4 (tense) 0.291.

These correlations suggest that a high score on the Word

Connection List is indicative of a high degree of anxiety.

Eysenck's Extraversion

This twenty-five item questionnaire attempts to measure the degree to which an individual prefers social relationships to more solitary kinds of activities. Examples of the kinds of items an extravert would be expected to answer "yes" to are:

Q. 1 Do you often act and speak on the spur of the moment?

Q. 16 Are you much given to telling jokes to your friends?

The tendency would be for the extravert to answer "no" to such questions as:

Q. 23 Are you inclined to be shy in the presence of the opposite sex?

Q. 33 Do you normally limit your acquaintance to a select few?

The pattern of responses for introverts would tend to be reversed. A high score on this scale represents a tendency towards extraversion, the highest possible score being 25.

The instrument is a revision of the _Maudsley Personality Inventory_ (McLeish, 1970). In a sample of 164 American post-graduate students, the scale correlated with Cattell's _16 Personality Factor Test_ to the following extent:

Factor A (warm, outgoing) 0.310;

Factor E (dominant-submissive) 0.406;

Factor F (enthusiastic) 0.598;

and with

Factor H (adventurous) 0.682.

Negative correlations exist between scores on the scale and Cattell's

Factor M (eccentric) - 0.238;

Factor Q2 (self-sufficient) - 0.314;

and Factor Q4 (tenseness) - 0.212.

This evidence suggests that the dimension being measured is one of introversion-extraversion.

Eysenck's Neuroticism

This scale measures the degree to which an individual accepts as describing himself, certain statements which are also accepted by persons who are disturbed mentally. The scale is not diagnostic in that a high score does not necessarily represent the exhibition of neurotic behaviour. It differs from the psychiatric meaning of neuroticism in this regard. A high score (possible score 18) indicating a tendency towards neuroticism might originate from the acceptance of such statements as:

Q. 8 Are your feelings easily hurt?

and the rejection of such statements as:

Q. 6 In general, do you prefer well-ordered hours and an established routine?

In a sample of 3,155 students, the scale correlated with

factors on the Cattell 16 Personality Factor Test to the following extent:

with Factor C (general instability) 0.226;

with Factor G (weakness of character) 0.322;

with Factor M (eccentric) 0.235;

with Factor O (anxious insecurity) 0.360;

with Factor Q3 (uncontrolled) 0.255;

and with Factor Q4 (tenseness) 0.403.

Correlations with intelligence and examination results were negative but not significant (McLeish, 1970). These correlations suggest that the dimension being measured is one of neuroticism-stability. Both neuroticism and extraversion scores are derived from responses to Scale II of the Survey entitled "Personal Opinions" (see Appendix 1).

Internal-External Locus of Control

This scale by Rotter (1966) was an attempt to quantify individual differences in a generalized expectance or belief in external control as a psychological variable. The scale consists of 29 items, six of which are filler items to make the purpose of the test appear somewhat ambiguous. Subjects are asked to respond to one of two choices which most closely represents the subject's belief about the nature of the world, in terms of how reinforcement is controlled. An individual who perceives the control of

reinforcement to be external would tend to choose "a" in the following example, while an internal individual would tend to choose "b".

9. a. I have often found that what is going to happen will happen.

   b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

A high score on the scale, to a maximum of 23, represents the subject's degree of externality. A copy of the questionnaire is found in Appendix 2.

Rotter reported that a factor analysis of the items showed that all items loaded significantly on the general factor which accounted for 53% of the total variance. The scale correlated with the Marlowe-Crowne Sociability Scale from between - 0.07 to - 0.35. Correlations with intellectual measures are reported to be uniformly low.

A more recent study by Gurin, Gurin, Lao and Beattie (1969), however, has suggested that Rotter's scale is not unidimensional. They suggested that while an individual might see himself as master of his own destiny, that is, internally controlled, he might feel that this is not true of the general population. The authors suggested that there are at least two dimensions being measured here, one of personal control and another of control ideology. They have suggested that it is the dimension of personal control

which is most highly correlated with performance. In their factor analytic study of a number of scales including Rotter's, they found that the five items which loaded highly on the personal control factor, were five items from Rotter's 29-item scale (see Appendix 2).

While it was not originally planned, it is possible to sum the responses to these five items of Gurin's from within the Rotter scale, and produce a score for each individual based on a personal locus of control. A high score, in this instance to a maximum of 5, represents the subject's degree of personal externality. Since students who are classified as internals perceive reinforcement as contingent on their own actions, and are more highly motivated than externals, it is suggested that the degree to which a student is externally oriented will have a direct influence on his learning performance.

Criterion Learning Test

The criterion learning test consisted of thirty multiple-choice items based on the material presented in three CAI lessons. Most of the items had been used in previous studies (for example, Roid, 1971a) and had been improved after item analysis. A specimen question from the criterion test, based on the first of the three CAI lessons, is given below. The complete set of thirty items is found in Appendix 3.

1. Suppose a cat on whom a brain operation has been performed learned the following two experimental behaviours:
   1) to touch a red rather than a white square to obtain food when its right eye is covered and its left eye is open;
   2) to touch the white rather than the red square to obtain food when its left eye is covered and its right eye is open.

   What characteristics of sensory and motor pathways in the nervous system is demonstrated by this evidence?

   a. parallel conduction
   b. point-to-point projection
   c. divergent conduction
   d. all-or-none principle

Most of the items presented the student with four possible responses, but in the case of a few items this varied from three to five choices. It will be noted that the nature of the material is highly technical and not likely to be the sort of knowledge one would acquire without specific study.

In an effort to derive some data as to how people score on the test without having taken the three CAI sessions on which the test is based, the test was administered unannounced to a class of more than fifty education students at the University of Alberta. Unfortunately, this group of students did not approximate the students in the experimental group with respect to their background knowledge of psychology. The University of Alberta students were superior in that all had taken at least two half-courses in psychology previously, and some had credit in as many as six half-courses in psychology and/or biology and other related fields.

In spite of the relatively high background knowledge possessed by the University of Alberta students, their mean score on the test was low. The mean score for the entire group was 13.49 (N=51) and when fourteen of the highly knowledgeable students were removed, the mean fell to 12.16. Although this score is above chance level, probably due to their previous experience in psychology courses, it is significantly lower than one might expect of students were they to study the three relevant CAI lessons. If a less knowledgeable group (for example, our experimental subjects) were to score significantly higher after having taken the three lessons, then it would lend support to the conclusion that the higher scores are due to learning from the lessons and that the criterion test is, in fact, measuring that learning.

The reliability coefficient based on internal consistency as estimated by the Kuder-Richardson Formula 20 was found to be 0.652 (N=311 experimental subjects), indicating that the test is fairly homogeneous considering its length was only thirty items. Were the test lengthened to sixty items, its reliability as estimated by the Spearman-Brown formula would increase only to 0.789, suggesting that the lower reliability of 0.652 for the thirty item test is due mainly to its shorter length rather than low homogeneity.

The criterion learning test was administered <u>individually</u>

to each student in paper-and-pencil format and not on the computer terminal. Although many of the students had learned the material by working in groups at computer terminals, each student was required to respond individually and independently since the object of the study was to examine the effect of group work on individual learning.

Each student took the criterion learning test one week after the final CAI lesson to ensure equal time intervals between lessons and evaluation for all students. This meant that the criterion test had to be administered on five occasions. Students responded to each item and recorded their answers on a standard machine-scored answer sheet for subsequent scoring and analysis.

Teaching Methods Questionnaire II

The Teaching Methods Questionnaire II is a revision by the author of the Teaching Methods Questionnaire (McLeish, 1970). The original questionnaire consisted of three scales of ten items each, designed to elicit attitudes towards the lecture, tutorial, and seminar methods of teaching. Items from a scale by Foster (1970) were revised by the author and were added to the questionnaire to form two additional scales designed to elicit attitudes towards PI and CAI.

The questionnaire then, yields five scores, one for each of the teaching methods involved. On each scale, a score of thirty represents the maximum favourable attitude, a score of fifteen represents the point of neutrality, and a score of zero represents the maximum unfavourable attitude. Items worded favourably in the questionnaire are scored 3, 2, 1, or 0, to correspond with a response of strongly agree, agree, disagree, strongly disagree, respectively. Items worded unfavourably are scored in the reverse direction. A copy of the questionnaire is found in Appendix 4.

Each of the scales represents a crude measure of an individual's attitude towards that particular teaching method. Scores among the five scales are not directly comparable since it is doubtful that the items elicit attitudes along the same dimension for each of the five teaching methods. Further, for the original questionnaire, no data was available on the validity or reliability of the scales (McLeish, 1970). Part of the present study was concerned with determining a measure of test-retest reliability. With reliability established in this way, it was hoped that the scales could be used as a pretest and a post test of attitudes towards the various teaching methods, including CAI.

Fifty-four senior undergraduate and post-graduate students in the Faculty of Education at the University of Alberta participated in the reliability study. It was felt that the

characteristics of this group would most closely resemble those of the subjects in the experimental study, with respect to educational level.

The questionnaire was administered to the students twice over a three-week period and the scores correlated. In addition, a correlated "t" test was applied to test the significance of the difference between pre and post test means. The results of this study are found in table 3.

TABLE 3

THREE WEEK TEST-RETEST ON
THE TEACHING METHODS QUESTIONNAIRE II

Teaching Method	Test	Means	s.d.	t test means	p	reliability coefficient
Lecture	pretest	11.09	4.04	-0.567	0.573	0.716
	posttest	10.87	3.75			
Tutorial	pretest	17.91	2.93	-1.247	0.218	0.574
	posttest	17.46	2.81			
Seminar	pretest	21.28	4.34	-0.974	0.334	0.651
	posttest	20.83	3.69			
Programmed Instruction	pretest	15.15	4.16	2.874	0.006	0.728
	posttest	16.31	4.14			
Computer-Assisted Instruction	pretest	19.64	3.53	0.899	0.373	0.697
	posttest	20.00	3.95			
TOTAL SCORE	pretest	85.07	7.80	0.468	0.641	0.760
	posttest	85.48	10.09			

(N=54)

As may be seen from table 3, only in the case of programmed instruction is there a significant difference between the pretest and posttest means. On reflection, it was realized that several lectures on PI were given during the three-week interval between the two tests, and that the students' text contained information about PI. In all likelihood, this accounts for the significant positive shift in attitude on this dimension.

The internal reliability of each of the sub-scales is expectedly low due to there being only 10 items in each sub-scale. The sub-scale KR-20's were found to be 0.52, 0.49, 0.53, 0.34, and 0.39 for lecture, seminar, tutorial, PI, and CAI, respectively. The internal reliability of the entire fifty items (KR-20) was found to be 0.725 (N=411, University of Alberta and McGill University students). This is a reasonably high reliability coefficient for an attitude scale and suggests that the scores may be additive. In this way, it is possible to derive a total score for each student representing what may be thought of as an attitude towards teaching methods in general.

Among the 54 students in the test-retest reliability study, it is noted in table 3 that there was no significant difference between the pretest and posttest means on total score, but that in the case of the standard deviation, there has been a significant increase. It is probable that added experience, exposure to new educational concepts and the like, contributed to the greater

spread of scores in the posttest. The mean, however, remained relatively stable.

The test-retest reliability coefficients are given for each of the sub-scales and the total score. With a test-retest reliability over a three-week period of 0.76 (index of reliability =0.871), it would appear that the test is reasonably reliable. With this information it was felt that the test could reliably serve as a pretest and a posttest of attitudes for the experimental groups.

Information Questionnaire

This questionnaire consisted of seven items designed to provide classifications of students with respect to their opinions and the circumstances under which their group participated in the three lessons. Students were asked to respond individually as to whether all their group members had been present for each lesson, if they operated the terminal, what they thought was the ideal group size and similar questions. A copy of the questionnaire is found in Appendix 5.

Software

The Programming Language

The CAI lessons used in this study were coded in an author language developed by the Centre for Learning and Development at McGill University. The language is known as MULE: the McGill University Language of Education. The language is written in Fortran and is similar to one developed by Silvern (1968).

Lessons are coded for input to the MULE compiler. When the lesson has been saved on disk, it can be called from any remote terminal on the RAX time-sharing system. The student then proceeds through the instructional dialogue, "conversing" in natural language with the executing program. The MULE language also makes provision for storing student records in a disk file, for use by the instructor at a later date (Roid, 1970; 1971b; 1971c).

The CAI Lessons

The three CAI lessons were designated:

Lesson 1 - The Nervous System: Pathways in Learning and Perception
Lesson 2 - Modes of Sensory Control: Higher and Lower Behaviour
Lesson 3 - Sensory Stimulation, Arousal and Motivation

The lessons were based on chapters three and four of Hebb (1966) and were originally designed for an introductory psychology

course at McGill University, Psychology 200. They have been used several times with different groups of students and each time subsequent improvements made. Each lesson consists of about 35 frames, requiring the student to respond by typing in a word or phrase. Together the three lessons form an integrated unit of work. Lesson 1 took about an hour to complete and was basically a linear program. Lesson 2 and Lesson 3 each took about forty minutes to complete and provision was made in both for branching, review, and remedial sequences.

A written version of the lessons also exists and was used in a study comparing CAI presentation with printed presentation. No mean differences in learning performances were found between modes of presentation, but it appeared that CAI significantly increased the variances in learning performance (Roid, 1971a).

The lessons were chosen for use in this study because of success with their previous use, their subsequent revision and ready availability, and because it was felt that introductory educational psychology students would have little or no familiarity with the technical material comprising the lessons.

Hardware

The hardware used in the study consisted of eight Bell Datacom Model 33 teletype terminals. These were located in

Burnside Hall, the new computer science facility at McGill University. The terminals were connected by acoustic couplers and ordinary voice-grade telephone lines to the McGill University IBM 370/155 RAX time-sharing computer.

In addition to these terminals, students who lived in other areas of the city arranged with their group to take the CAI lessons on other available terminals. These were located at Sir George Williams University, Loyola College, The McGill Faculty of Management, Bishop Whelan High School, Marianapolis College, and MacDonald College of McGill University. Students who decided to use these facilities were responsible for ensuring that their group met at the appointed time and place, and that the lesson print-out was submitted immediately on return to McGill. Although the number of students who used these additional facilities was minimal, those who did appreciated the added flexibility of remote computer-assisted instruction.

Data Collection

The data to be collected consisted primarily of scores for each of the 309 individuals on the Survey of Educational Opinions, Rotter's Internal-External Locus of Control Scale, the criterion test, the seven-item questionnaire of basic information, and the pre and post test of the Teaching Methods Questionnaire II. All of these questionnaires were of the paper-and-pencil variety.

Data for each lesson execution was stored automatically by the computer. The RAX system also stored all the accounting information for each group, since each group used their group number as part of their sign-on identification. The MULE program which ran the lessons recorded automatically on a disk file each response made, the time of day, the elapsed time, and the number of responses correct, incorrect and unrecognizable.

The Survey of Educational Opinions, and the Teaching Methods Questionnaire II both utilized custom designed over-printed IBM answer sheets for data collection. Each student was provided with an HB pencil and asked to complete the questionnaires using the answer sheets provided. Five specially-printed answer sheets were required for this purpose. A sixth general-purpose answer sheet was used to gather information with respect to the criterion test, the locus of control scale, and the 7-item questionnaire. About 2000 answer sheets were used in all, and these were subsequently relayed to the University of Alberta for scoring by an IBM 1130 optical scorer. This machine punches 80-column Hollerith cards from the information contained on the answer sheets, facilitating later scoring and analysis by computer.

The availability of mechanized resources for the collection, manipulation and analysis of data now permits the study of samples larger than was previously possible. The use of technology in this experiment to assist in the collection and analysis of data,

permitted the study of a sample of several hundred students. Such large samples make possible increased confidence in the conclusions drawn from the data. Further, the use of the computer in data analysis reduces the probability of possible computational error often associated with statistical analysis.

Summary of Chapter

The chapter provided a statement of the problem and formulated six hypotheses to test the relationships between group work in CAI and learning performance, attitudinal variables, personality variables and cost factors. A description of the research design and randomization procedure were given, and the measuring instruments described. Finally, a note was included describing the software and hardware used in the study, as well as the method of data collection.

CHAPTER IV

ANALYSIS OF THE DATA

Overview of the Chapter

This chapter presents the results of the analyses based on the hypotheses formulated earlier in Chapter III. The results are presented in tabular form and correspond to the order of their earlier presentation. In addition, the results of some supplementary analyses are presented. These deal with the nature of the responses made during the course of each lesson, and their relationship to performance on the criterion test.

Results of the Analyses

Hypothesis 1 - Learning

A simple one-way analysis of variance procedure was used to test hypothesis 1, that the learning performance of students taught in groups by CAI is equal to or better than that of students taught individually by CAI.

Table 4 presents the means and variances of individual learning scores for the four treatments. It would appear from inspection that there is little difference among the means.

TABLE 4

MEANS AND VARIANCES OF INDIVIDUAL LEARNING SCORES FOR THE FOUR TREATMENT GROUPS

Treatment Group	N	Mean	Variance
1. individuals	78	16.22	20.15
2. pairs	61	15.89	14.64
3. groups of three	80	16.04	14.52
4. groups of four	63	15.92	18.27
Total Subjects	282	16.03	16.72

The results of the analysis of variance of the individual learning scores for the four treatment groups are presented in table 5. As the figures indicate, no significant differences were found among the four treatments for either mean individual learning scores or variances.

TABLE 5

ANALYSIS OF VARIANCE OF LEARNING SCORES
FOR THE FOUR TREATMENTS

Source	df	Sum of Squares	Mean Square	F	p
Groups	3	4.813	1.60	0.09	0.96
Error	278	4709.000	16.94		

Homogeneity of Variance test: Chi square=2.90, p=0.41; N=282

These findings support Hypothesis 1 in that the variation observed in the sample means would be expected if the four groups had originated from the same population. Thus it appears that individuals learn equally well from CAI whether they work alone, in pairs, or in groups of three or four.

Whenever "conventional" instructional methods are compared with CAI, it is not uncommon to find that there are no mean differences among treatments. It is often found, however, that the CAI method increases the variances of the learning scores (Wassertheil, 1968; Roid, 1971a). These results are usually interpreted as support for the belief that CAI is more highly "individualized" than other instructional methods: the extent of this individualization being reflected in the wider variability of the scores.

The present study of course, does not attempt to compare CAI with other instructional methods. Rather the emphasis has been

to study the effectiveness of CAI under various conditions of group size. If teaching the same lesson to several students does in fact lessen the extent of individualization within that lesson, there might be expected less variability in the scores of students who learned in groups. This would certainly be the case if group learning scores were to be used as indicators of individual learning. In the present study, however, each student was tested individually even though he may have learned in a group setting. Yet there were no significant differences in variances among the four treatments. One interpretation of this finding in light of the foregoing arguments is that the learning of individuals in groups was just as highly individualized as the learning of those who worked alone.

Hypothesis 2 - Attitudes

Effect of Group Size on Attitude Towards CAI

Hypothesis 2 was concerned with establishing whether or not, after exposure to CAI as a teaching method, there was a significantly greater increase in positive attitudes towards CAI among students who worked in groups than among students who worked individually. The research design to test this hypothesis included a pretest of attitudes towards five teaching methods before exposure to CAI, as well as a posttest of those same

attitudes after the CAI treatment. This method enabled the establishment of an attitudinal baseline from which subsequent change could be measured. To determine if there were significant differences in posttest attitudes among the four treatment groups, controlling for pretest attitudes, an analysis of covariance technique was employed. In the first analysis, the pretest attitude towards CAI was used as the covariate, and the posttest attitude towards CAI was used as the dependent variable. The results of this analysis are found in table 6.

TABLE 6

ADJUSTED ANALYSIS OF VARIANCE USING PRETEST ATTITUDE TOWARDS CAI AS COVARIATE, AND POSTTEST ATTITUDE TOWARDS CAI AS CRITERION

Source	df	Mean Square	Adjusted F	Probability
Group	3	31.339	1.708	0.165
Within	304	18.352		

The attitude scores of both the knowledgeable and unknowlegeable groups with respect to background in psychology were included in this analysis. As may be seen from the figures in table 6, a comparison of CAI attitude score means among the four treatment groups, controlling for pre-instruction attitude scores showed no significant differences. Further inspection of the regression weights for the four groups indicated that the

slopes of the regression lines in the four treatment groups were relatively homogeneous. It would appear then, from this analysis, that assigning students to work in groups as large as four does not significantly affect their attitudes towards CAI as an instructional system.

The Teaching Methods Questionnaire II yielded scores of five subscales, each representing an attitude towards a particular teaching method. It was thought that since attitudes towards CAI may be reflected to some extent in attitudes towards PI, that both of these pretest scores might be used as covariates to yield a more stable picture of the effect of group CAI conditions on post-test attitudes towards CAI. As well, it was decided to perform a third analysis using the scores on all the pretest variables as covariates. This meant that scores representing attitudes towards lecture, tutorial, seminar, programmed instruction, and computer-assisted instruction, were used to control for what might be called a general attitude towards teaching methods. The results of these analyses are found in tables 7 and 8.

From an inspection of the regression weights for each treatment group it was noted that the slopes of the regression lines were relatively homogeneous. It can be seen from the results in tables 7 and 8 that the addition of predictor variables in the form of attitude scores based on other teaching methods had little effect on the adjusted means of the four treatments.

TABLE 7

ADJUSTED ANALYSIS OF VARIANCE USING PRETEST ATTITUDES TOWARDS PI AND CAI AS COVARIATES, AND POSTTEST ATTITUDE TOWARDS CAI AS CRITERION

Source	df	Mean Square	Adjusted F	Probability
Group	3	30.135	1.640	0.180
Within	303	18.366		

TABLE 8

ADJUSTED ANALYSIS OF VARIANCE USING PRETEST ATTITUDES TOWARDS LECTURE, SEMINAR, TUTORIAL, PROGRAMMED INSTRUCTION AND CAI AS COVARIATES, AND POSTTEST ATTITUDE TOWARDS CAI AS CRITERION

Source	df	Mean Square	Adjusted F	Probability
Group	3	29.767	1.622	0.184
Within	300	18.343		

No significant differences in final mean scores for attitude towards CAI were noted among the four groups.

Effect of Group Size and Attitudes on Learning

A number of significant correlations were found to exist between the learning criterion scores and the attitudes toward various teaching methods. These results are found in table 9.

It will be noted that scores on the criterion test correlate significantly, though not necessarily positively, with attitude scores for lecture, seminar, and CAI.

TABLE 9

INTERCORRELATIONS AMONG PRETEST ATTITUDES TOWARDS TEACHING METHODS, AGE, AND CRITERION TEST

	2	3	4	5	6	7
1. Age	.053	.042	-.110	.033	.029	.055
2. Criterion test		-.129[1]	-.018	.117[1]	.010	.210[2]
3. Lecture attitude			.040	-.192[2]	-.015	-.018
4. Tutorial attitude				.108	-.009	.045
5. Seminar attitude					-.018	.229[3]
6. Programmed Instruction attitude						.380[3]
7. Computer-assisted Instruction attitude						

[1] $p < .05$; [2] $p < .001$; [3] $p < .0001$; N=282

As will be seen later in table 11, none of the personality variables used in this study correlated significantly with performance on the criterion. The existence then, of significant correlations between performance on the criterion and certain attitudes toward teaching methods suggested that perhaps these attitude scores might prove to be better predictors of learning

success than the personality variables. For this reason, several analyses of covariance were performed using various combinations of attitude variables as covariates. However, when the effects of these attitudes on learning were statistically controlled, no significant differences were found among the adjusted learning score means of the four treatment groups. It would appear that while certain attitudes to teaching methods were related to performance in CAI, the strengths of these relationships were reasonably consistent across all the groups. Attitudes towards various teaching methods then, did not affect learning differentially among the various size groups.

Hypotheses 3, 4, 5 - Personality Variables

Hypotheses 3, 4, and 5 dealt with the effect of certain personality variables on learning performance under varying conditions of group size. Specifically, it was predicted that with respect to performance, students classified as extraverts would excel under group conditions; that students classified as neurotic would excel under individual CAI conditions; and that students classified as "internal" would tend to surpass the performance of students classified as "external".

An analysis of covariance design was used to determine the effect of these personality variables on learning under varying conditions of group size. Scores on four personality variables

were used as covariates: Rotter's locus of control, anxiety, extraversion, and neuroticism. No mention was made of anxiety in the original hypotheses since anxiety has often been found to be highly correlated with neuroticism. However, since the correlation between neuroticism and anxiety in the present study was found to be much lower than expected ($r=.264$, $p<.001$, $N=282$) and since numerous studies have related anxiety to performance, it was decided to include anxiety as an independent variable. The results of the analysis are found in table 10.

TABLE 10

ADJUSTED ANALYSIS OF VARIANCE OF CRITERION SCORES AMONG THE FOUR TREATMENT GROUPS USING LOCUS OF CONTROL, ANXIETY, EXTRAVERSION AND NEUROTICISM AS COVARIATES

Source	df	Mean Square	Adjusted F	Probability
Group	3	1.498	.0868	0.967
Within	274	17.257		

As can be seen from the results of the analysis, controlling for the effect of the four personality variables produced no significant differences in learning among the four treatment groups. To test for possible interactions between each of the four personality variables (high and low groups based on median split) and four levels of group size, seperate two-way analyses of variance were performed. No significant interactions or main effects were found.

Table 11 presents the correlations for personality variables, age, and criterion test scores (correlations for each treatment are found in Appendix 6). As may be seen in table 11, significant

correlations exist between age and Rotter's locus of control, neuroticism and locus of control, and neuroticism and anxiety.

TABLE 11

PEARSON PRODUCT-MOMENT CORRELATIONS FOR AGE, CRITERION TEST SCORES AND PERSONALITY VARIABLES

	2	3	4	5	6	7
1. Age	.053	$-.139^{1}$	-.080	-.110	-.074	-.113
2. Criterion Test		.068	-.028	.009	.089	-.002
3. Rotter's Locus of Control			$.733^{3}$	.040	-.033	$.153^{3}$
4. Gurin's Personal Locus of Control				.036	-.036	$.177^{2}$
5. Anxiety					-.001	$.264^{3}$
6. Extraversion						-.049
7. Neuroticism						

$^{1}p=.02$; $^{2}p<.01$; $^{3}p<.001$; N=282

An inspection of these correlation coefficients reveals that none of the personality variables correlated significantly with the criterion test. These low correlations are consistent with the results reported in table 10.

During the course of the study, the question was brought up as to whether or not the effect of certain personality variables on learning with CAI might be masked by the personality composition of the group. For example, in a small group, learning might be as

much related to a partner's personality orientation as to the subject's own orientation. An extravert paired with another extravert might well surpass the performance of an extravert paired with an introvert. Because the subjects in this study were randomly assigned to groups, the effects of such pairing might be hidden.

For preliminary purposes it was decided to examine only the scores of students who had worked in pairs. The median score on the introversion-extraversion scale was used to classify students as either introverts or extraverts. Once this was done, the group's personality composition could then be determined by classifying each group as an introvert-introvert, extravert-extravert, or introvert-extravert pair. Of the sixty students who had worked in pairs, there were found to be nine pairs of introverts, nine pairs of extraverts, and twelve mixed pairs.

A simple one-way analysis of variance was used to compare these three groups on criterion test scores. No significant differences were found among any of these three groups ($F=1.37$, $p=0.26$), suggesting that the personality composition of the group does not significantly affect the learning of individuals in the group.

Several other analyses of covariance were performed using different variables as covariates. For example, the effect of

sex and age on performance were examined for the four treatment groups. No significant differences were found. In another analysis, responses to questions 4 and 5 of the Information Questionnaire dealing with participation in response formulation and actual terminal operation, were used as covariates to ascertain their effect on performance. Controlling for these, no significant differences in learning were found among the treatment groups. Finally, the effect of course grades on performance was examined. It was thought that the grade each student attained in the course, which was unrelated to the CAI work, might serve as a crude indicator of scholarity and hence be used to predict CAI performance. Once again however, an analysis of covariance indicated no significant differences among the groups.

It was decided not to use Gurin's Personal Locus of Control as a covariate since its correlation with learning was non-significant ($r=-0.028$). The significant correlation between the Gurin scale and Rotter's Locus of Control scale is probably spuriously high ($r=0.733$) since the five items of the Gurin scale originated from the twenty-nine items of Rotter.

Hypothesis 6 - Elapsed Lesson Time

Hypothesis 6 predicted that no differences in elapsed time would be found among the four treatment groups. In other words, it was expected that groups would move through each of the lessons

as quickly as individuals.

Table 12 presents the means and standard deviations of the elapsed time for each lesson for each of the four treatments. Elapsed time represents only the amount of terminal connection time used from the beginning to the end of each lesson, excluding time used for sign-on and sign-off procedures. Each score represents a group time score: for example, a group of four is assigned a single elapsed time for each lesson.

TABLE 12

MEANS AND STANDARD DEVIATIONS OF ELAPSED TIME FOR THE FOUR TREATMENTS

CAI Lesson		Group Size 1	2	3	4	Groups 2, 3, & 4 combined
lesson 1	mean	61.64*	60.01	61.81	57.44	60.24
	s.d.	16.06	13.21	9.95	7.27	10.96
	Ng	46	22	21	10	53
lesson 2	mean	38.85	34.85	36.33	36.37	35.69
	s.d.	10.15	8.80	6.12	6.25	7.37
	Ng	78	31	26	14	71
lesson 3	mean	40.17	37.60	37.49	36.43	37.32
	s.d.	9.15	7.08	6.20	6.27	6.52
	Ng	76	29	26	14	69

Ng=number of groups
*time in minutes

It will be noted that the number of observations available for time scores on lesson 1 are greatly diminished. This was due

in part to a malfunction of one of the programs used to retrieve student data from the disk file and then empty the file for future use. Before the program could be corrected, a number of scores were lost because the file had been completely filled and no more data could be stored. The program was corrected as soon as possible. A few scores were also lost for lessons 2 and 3, but for other reasons. It was found that student performance recordings were affected by the accidental disconnection of the computer terminal from the computer. This was accomplished by overly-enthusiastic students jarring the sensitive acoustic coupler by which the connection was made. Resuming the program under these conditions would distort the actual time score as recorded by the MULE compiler.

Of a possible 156 groups, 54 scores are missing for lesson 1, 7 for lesson 2, and 11 for lesson 3. Since it may be assumed that the malfunctions occurred on a random basis, it is probable that there is no systematic influence in the data. This makes it unlikely that the analyses would be markedly affected, especially since the number of missing scores for lessons 2 and 3 is quite small in proportion to the total number of possible scores.

To test hypothesis 6 that there were no significant differences in elapsed time scores among treatments, four analyses of variance were performed on the elapsed time in minutes for each of the three lessons, and for the average time of the three

lessons. The results of these analyses are found in table 13.

TABLE 13

ANALYSES OF VARIANCE OF ELAPSED LESSON TIMES FOR THE FOUR TREATMENTS

Lesson	Source	df	Sum of Squares	Mean Square	X^2	p	F	p
1	Groups	3	179.938	59.89	10.61	.014	0.32	0.81
	Error	95	17718.187	186.51				
2	Groups	3	410.000	136.67	10.86	.012	1.69	0.17
	Error	145	11699.125	80.68				
3	Groups	3	307.500	102.50	7.64	.054	1.58	0.19
	Error	141	9147.625	64.95				
Mean Time	Groups	3	167.125	55.71	2.63	.451	0.54	0.66
	Error	152	15744.500	103.58				

X^2 represents Chi square homogeneity of variance test

As indicated by the figures in table 13, no significant differences in elapsed time are evident among the four groups for any of the three lessons or for the average time of all lessons combined.

In the three comparisons involving lessons 1, 2, and 3, it is noted that homogeneity of variance is not always present. With the largest F ratio being as small as 1.69, however, it is unlikely that the unequal variances would have a significant effect on the comparison of means. It is also true that the F test in the analysis of variance is robust with respect to violations of the

homogeneity of variance assumption (Winer, 1962). The fourth analysis of variance reported in table 13 compared mean scores among the four treatments using as time scores the average time taken by each group over the three lessons. Again, no significant mean differences are found, and homogeneity of variance is present.

Inspection of the actual mean scores for elapsed time (table 12) does indicate a trend, however. In all three lessons, it appears that students working in groups tend to move through each lesson slightly faster than those students working alone. For this reason it was decided to combine groups 2, 3, and 4 and compare the mean score of each lesson with group 1. On lesson 1, a linear program, it was found that there were no significant differences between those who worked alone and those who worked together. On lessons 2 and 3, both branching programs, it was found that those who worked together moved through the lessons significantly faster than those who worked alone (Welch t' approximation=2.19, $p=.015$ for lesson 2; $t'=2.17$, $p=.032$ for lesson 3). It is likely, however, that these results are simply artifacts of the statistical procedure brought about by combining groups 2, 3, and 4. It must be pointed out again that in the original comparison of the four groups there were no statistically significant differences in elapsed time scores, but there appears to be a non-significant trend for people working together in groups to complete branching-type lessons slightly faster than individuals working alone.

Analysis of On-Line Responses

Since the results of the previous analyses had suggested that there were no significant differences in learning or elapsed time scores among different sized groups, it was thought that if any differences existed at all among the treatments, they might emerge "on-line"[1] rather than in posttest scores of learning. For this reason, it was decided to examine the average number of correct, incorrect, and unrecognizable[2] responses per lesson made by each group in an attempt to determine their effect on criterion test performance.

The means and standard deviations of correct, incorrect, unrecognizable, and total number of responses, averaged over the three lessons for all groups are presented in table 14.

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[1] "On-line" responses are those student responses made during the actual execution of each lesson.

[2] An unrecognizable response is one which the computer has not been programmed to recognize as correct or incorrect. Unrecognizable responses often represent unanticipated incorrect responses but in some cases may originate from correct responses spelled or typed incorrectly by the student. Whether responses are categorized as being incorrect or unrecognizable depends entirely on the extent to which incorrect student responses have been anticipated and provided for by the lesson programmer.

TABLE 14

MEANS AND STANDARD DEVIATIONS OF AVERAGE NUMBER
OF GROUP RESPONSES PER LESSON*

Type of Response		Group Size 1	2	3	4
Correct	mean	30.46	30.76	32.07	30.27
	s.d.	4.45	4.18	3.71	3.53
Incorrect	mean	3.65	3.10	2.88	2.84
	s.d.	1.49	1.28	0.95	1.21
Unrecognizable	mean	6.95	4.72	4.31	4.17
	s.d.	2.98	1.71	1.37	1.73
Total	mean	41.06	38.58	39.26	37.29
	s.d.	3.73	4.52	3.19	3.82
Number of groups		78	31	27	16

*averaged over three lessons

Analysis of variance procedures were used to determine if there were any significant differences among the four groups in mean number of correct, incorrect, unrecognizable, or total responses over the three lessons. The results of these four analyses are presented in table 15.

Homogeneity of variance was found to be present in each of the analyses except for the unrecognizable responses. As may be seen from the table, no significant differences were found among the four treatment groups for the number of correct responses. However, for both the number of incorrect and the

TABLE 15

ANALYSES OF VARIANCE OF AVERAGE NUMBER OF GROUP RESPONSES OVER THREE LESSONS

Analysis	Source	df	Sum of Squares	Mean Square	F	p
Correct Responses	groups	3	57.250	19.08	1.09	0.356
	error	148	2595.812	17.54		
Incorrect Responses	groups	3	19.202	6.40	3.55	0.016
	error	148	266.577	1.80		
Unrecognizable Responses	groups	3	240.340	80.11	13.70	<0.0001
	error	148	865.352	5.86		
Average Total Responses	groups	3	279.125	93.04	6.36	<0.0001
	error	148	2165.250	14.63		

number of unrecognizable responses, significant differences were found. These differences suggest that individuals working alone make significantly more errors than do individuals working together in teams. A Scheffé multiple comparison of means test indicated a significant difference between individuals and groups of three in the average number of incorrect responses per lesson ($p=.085$), and between individuals and groups of two, three, and four, in the average number of unrecognizable responses per lesson ($p<.001$). These differences must be interpreted cautiously, however, since neither the analysis of incorrect responses nor the analysis of unrecognizable responses is independent of the first analysis of correct responses in which there were no differences.

These results become a little more clear, however, in the next analysis, where the average number of correct, incorrect, and unrecognizable responses over the three lessons were summed to determine the average total number of responses per lesson for each group. An analysis of variance on these total scores (table 15) yielded a significant F ratio. A Scheffé multiple comparison of means test indicated that significant differences existed between individuals and groups of two and four ($p < .03$) in total responses made during the course of the lessons. No significant difference was found between individuals and groups of three but the trend was the same: individuals tended to make more responses than those who worked together. No significant differences in total number of responses were found among groups of two, three, or four students.

In table 16, each student was assigned his group score for number of correct, incorrect, and unrecognizable responses. Thus if a group voted to enter an incorrect response, each member of that group was counted as having made an incorrect response. For purposes of comparison, mean criterion learning scores are also listed. The slight discrepancy in means and standard deviations between tables 14 and 16 is due to a number of subjects dropping out before taking the criterion test. Only those subjects who completed the criterion test as well as the three lessons are listed in table 16.

TABLE 16

INDIVIDUAL SCORE MEANS AND STANDARD DEVIATIONS OF CRITERION TEST, AVERAGE CORRECT, INCORRECT AND UNRECOGNIZABLE RESPONSES FOR THE THREE LESSONS FOR THE FOUR TREATMENT GROUPS

Variable		1	2	3	4	
Criterion test	mean	16.22	15.89	15.94	15.92	
	s.d.	4.46	3.79	3.86	4.24	
Average number of correct responses	mean	30.46	30.92	32.14	30.30	
	s.d.	4.45	4.00	3.63	3.47	
Average number of incorrect responses	mean	3.65	3.09	2.85	2.81	
	s.d.	1.49	1.29	0.91	1.17	
Average number of unrecognizable responses	mean	6.95	4.73	4.31	4.12	
	s.d.	2.98	1.71	1.37	1.65	
	N	78	61	80	63	282

Having assigned each individual his group score for correct, incorrect, and unrecognizable responses, table 17 presents the correlations between those scores and the criterion learning scores. The purpose in deriving these correlations was to attempt to ascertain the effect of particular kinds of group responses made during a program, e.g. correct or incorrect, on individual learning measured subsequently by means of the criterion test.

As may be seen from the figures in table 17, significant correlations exist between criterion learning scores and the

TABLE 17

CORRELATIONS BETWEEN INDIVIDUAL CRITERION LEARNING SCORES AND AVERAGE NUMBER OF CORRECT, INCORRECT AND UNRECOGNIZABLE RESPONSES OF THE THREE LESSONS COMBINED

Correlation Between:		Group Size 1	2	3	4
Criterion and number of correct responses	r=	0.417[1]	-0.042	0.053	0.239
Criterion and number of incorrect responses	r=	-0.513[1]	-0.377[2]	-0.038	-0.130
Criterion and number of unrecognizable responses	r=	-0.460[1]	-0.260[3]	-0.103	-0.108
	N=	78	61	80	63

[1]$p < .001$; [2]$p < .003$; [3]$p = .043$

number of correct, incorrect and unrecognizable responses for individuals working alone. For students working in pairs, the number of correct responses seems to be unrelated to final performance on the criterion test. The number of incorrect and unrecognizable responses, however, are inversely related to the scores on the criterion test. For students working in either groups of three or four, the number of correct, incorrect or unrecognizable responses is unrelated to performance on the criterion test.

Summary of Chapter

This chapter presented the results of the statistical analyses performed on the data. The results suggest that learning in groups with CAI is at least as effective as learning alone with CAI; that group CAI does not affect student attitudes towards CAI as a teaching method; that personality variables of various types are unrelated to learning performance with either group or individual CAI; and that group CAI students move at least as quickly through each lesson as do their counterparts working alone.

It was also found that students who worked alone achieved the same number of correct responses but made significantly more errors than those students who worked in groups. All responses made during the lesson were significantly related to learning for those who worked alone, only errors were related to learning for those who worked in pairs, and the nature of the response was unrelated to learning for those who worked in groups of three or four.

CHAPTER V

DISCUSSION

Overview of the Chapter

This chapter discusses in detail the results of the analyses presented in Chapter IV. Some interpretation of the findings is given and the implication of these results within the theoretical framework of the study is examined. A theory of differential interpretation of feedback is proposed to explain the process of individualization within a group presentation. Practical implications are considered. The final section of the chapter summarizes the findings and suggests further areas of research.

Learning and the CAI Lessons

The experimental design of this study required subjects who had no knowledge of the material to be learned from the three CAI lessons. To achieve this objective, students in the experimental groups were selected for their lack of psychological knowledge in terms of previous course work. No pretest of learning based on the CAI lessons was given. It was unlikely, however, without

previous course work, that the highly technical material comprising the lessons would be familiar to the subjects. Nevertheless, without a pretest of learning, the design is always open to the suspicion that it is never really known whether or not any significant learning occurred as a result of the CAI lessons. Such a criticism may be based on two arguments: first, that nothing was learned from the CAI lessons and that student criterion scores did not differ significantly from chance; second, that if any learning indeed did take place, the criterion test was inadequate to measure it.

Learning and Its Measurement

One defence against these criticisms lies in the knowledge gained from the previous use of both the CAI lessons and the items comprising the criterion test. Evidence exists to suggest that not only did significant amounts of learning take place, but that this was measured by the criterion test. In an experiment by Roid (1971a) in which students used the same three CAI lessons, both pretests and posttests of learning were administered. It was found that there were significant increases in performance between pre-tests and posttests of learning for each of the three CAI lessons. Since the items from those pre and posttests of learning made up the criterion test in the present study, it can be argued that the test is a valid measure of students' learning from the three CAI lessons.

Learning Above Chance Levels

The next question to be considered is, "To what extent did performance on the criterion test differ from chance?"

In any multiple-choice examination where items have four possible choices, unless a correction is made for guessing, it is possible that the mean score of students answering each item at random would be approximately 25%. The mean score in the present study, however, was 53.4%. While this score is not a very high one, it does suggest that, in general, the responses to the criterion test were not made at random.

If it is accepted that the criterion test measured knowledge above chance level, a question might be put as to the origin of that knowledge. "Without a pretest, how can it be ascertained whether the criterion test measured knowledge gained from the CAI lessons, or previously acquired knowledge?" There is no way of knowing for certain that the performance on the criterion test was not already a part of each student's repertoire. The evidence, however, points to the contrary. First, the students were screened and in fact persuaded to join the knowledgeable group if they had any knowledge whatever of the subject matter area. Since there was no advantage attached to being in either the knowledgeable or the unknowledgeable group, it may be assumed that those who did have some background declared themselves to be knowledgeable. Second,

a group of fifty-two University of Alberta students were given, unannounced, a copy of the criterion test and asked to complete it. This group had considerably more knowledge in the area of psychology than did the experimental groups, yet without exposure to the CAI lessons, were unable to achieve a mean score as high as the experimental groups. This evidence points again to the fact that the lessons did teach, that the students did learn, and that the amount of learning involved was reflected in the criterion test scores.

The Low Mean Scores

It might well be asked, "If students were really learning from the CAI lessons, why were the mean scores on the criterion test so relatively low?" The low mean scores may be explained with particular reference to retention and motivation.

A. Retention

One explanation of the relatively low mean scores on the criterion test is that the students were being examined on material which had been learned from the computer up to three weeks previously. This is unlike many CAI studies which assess learning immediately after (or even during) the course of each lesson.

In addition, one must take into account the overall

circumstances under which the students worked. Each student was required to attend four hours of lectures per day over the course of a five-week period. Since most of the lectures in the different courses were unrelated, it is probable that this concentrated input of information inhibited retention.

B. Motivation

Even more important than retention in explaining the low mean learning scores, was the motivational level of the students. First, there was little incentive for learning under the CAI mode. No grades were affected as a result of successful completion of the CAI lessons: the lessons were completed as a course requirement. None of the material contained in the CAI lessons was examined as part of the course grade. In short, the students, faced with the pressures of other courses and other examinations, had little reason for learning the material at all, other than to receive credit for having completed the lessons. On the whole, it would have to be concluded that motivation was low, and that this low motivation was reflected in the low criterion learning scores.

On the other hand, a mean score in excess of 53% might well be considered routine under more conventional kinds of instruction.

The Lack of Learning Score Differences Among Treatments

As shown in tables 4 and 5, no significant differences in learning score means or variances were found among any of the four treatment groups. It was suggested in Chapter IV that one interpretation of this finding might be that the learning of individuals in groups was, in this study, just as highly individualized as the learning of those who worked alone. This raises the question, however, of how CAI can claim to provide individualized instruction when teaching more than one person simultaneously.

Individualized Instruction in Groups

The answer to this question again depends on the definition of "individualized instruction". The distinction was made, in Chapter I, between the terms "individual" and "individualized" instruction. It was suggested that "individual instruction" is any instruction provided on an individual basis but not necessarily geared to the needs of the student. "Individualized instruction", however, begins by assessing the needs and characteristics of each student and tailoring a lesson to meet those needs. It was suggested too, that individualized instruction need not be administered on an individual basis, as long as the needs of the student are met. With these definitions in mind, the nature of feedback in CAI and its relation to the learning process may be considered.

Differential Interpretation of Feedback

With the CAI system used in this study, group members discussed each frame of lesson material and decided on a single response to be entered on the terminal. This response was, in effect, a group response. Still, it was possible that certain members of a group might not agree with a majority decision. Students were given instructions that in case of dispute among members over a particular response, the majority decision ruled. In the case of a tie for students working in pairs or groups of four, the toss of a coin would be the deciding factor. It was possible then, for a member of a group to be out-voted in the determination of the response to be fed into the computer.

Once the group response was entered, it was evaluated by the computer, and the appropriate feedback message given. The feedback from the computer then, was in response to a group decision and not an individual decision. Since this was the case, it may well be asked how feedback occurring as a result of collective group action can affect an individual's learning, especially if that individual did not agree with or even participate in the original group decision. This would appear to be a serious question since there is a positive relationship between the number of people in each group and the potential number of disagreements therein.

One explanation is that while the computer provided feedback in response to a group decision, that feedback was differentially

interpreted by each group member. It is suggested that each group member interpreted the feedback message with respect to his original contribution to the group decision-making process and not the response finally entered. The following example illustrates the point.

A group of three working on a math drill is asked by the computer, "What is 2 x 3?" The group discusses the example and votes on an appropriate response. Two members of the group incorrectly believe the correct response to be "5". The third member says the answer is "6". He is out-voted and the incorrect response of "5" is entered. The response is evaluated and the computer returns the feedback message, "No, the correct answer should be 6. You added the numbers instead of multiplying them." Each group member reads the same feedback statement. However, while they all read the same words, the message content varies.

The two members who maintained the answer to be "5" now know they were incorrect and why they were incorrect. The third member who said the answer was "6" (even though his response was not evaluated by the computer) now knows that he had been right all along, and incidentally, that his partners were wrong. He compares the feedback statement, not against the response the group entered, but against his own original implicit response. The feedback statement is the same, but the message interpretation varies with the individual. It is suggested that in this way the program

maintains a degree of individualization.

This process of learning by CAI under individual and group conditions is presented schematically in Figure 3. For the students who work at the terminals individually, there is no discussion phase: each student arrives at an implicit response independently which in turn is made explicit by entering it on the computer terminal. For those who work in groups, discussion of the material precedes the entering of an explicit group response.

Ideally, if all the members of a group agreed on the response to be entered, the confirmation process for each member would be the same as for students who work alone. The response would be entered, evaluated by the computer, and the appropriate feedback given. The feedback would be compared with the response entered and since everyone agreed with the response entered, each member would receive the same information from the feedback statement. If the response entered were correct, positive reinforcement would result and the probability of learning would increase.

The combination of a well-designed program, together with students who have been matched according to background, intellect, motivational level, and other salient characteristics, might well ensure a high probability of response agreement in each group. However, the determination of which characteristics are relevant

Learning Through Differential Interpretation of Feedback

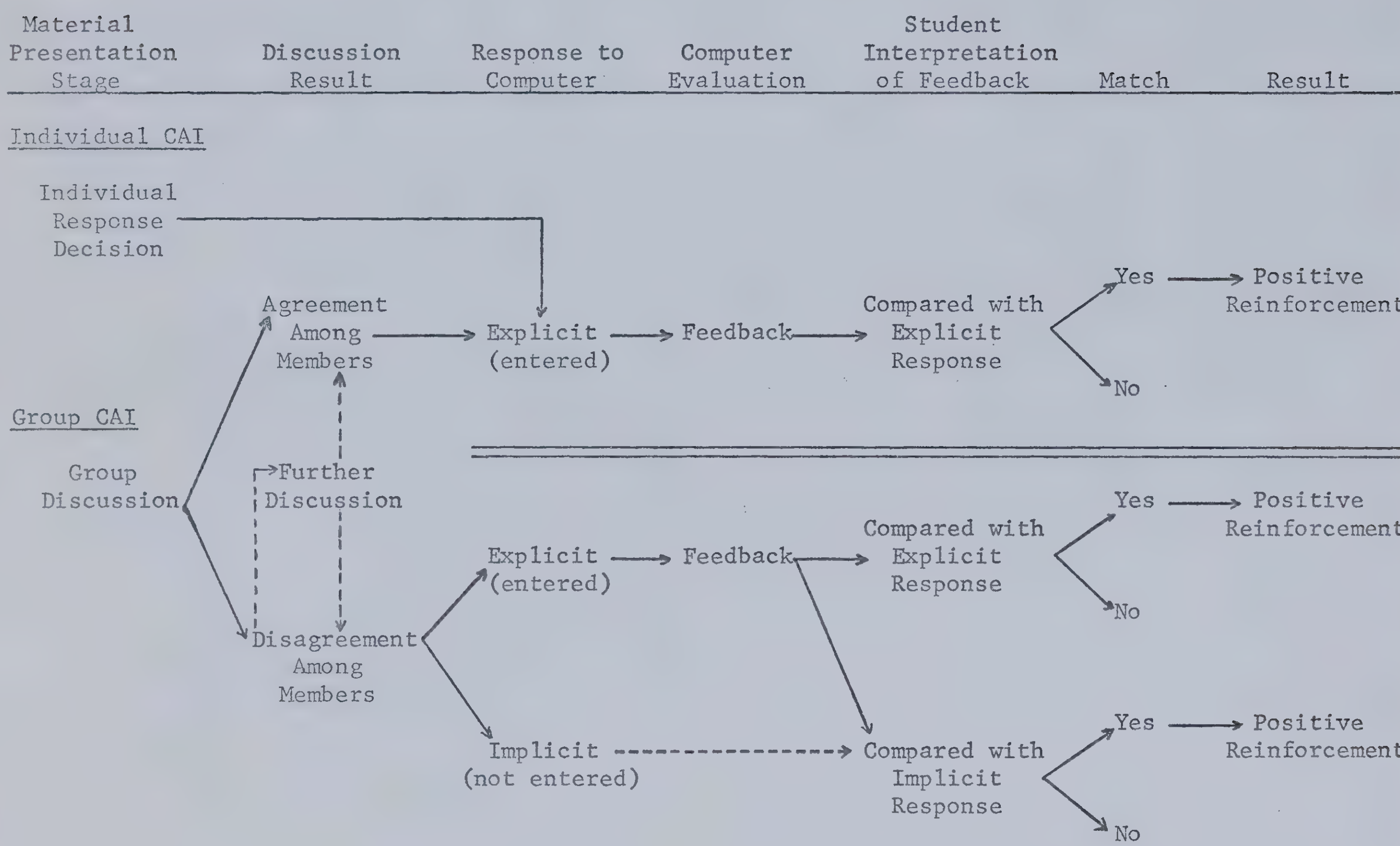

Figure 3

for matching students to optimize performance remains an area in which much research has yet to be undertaken. In practice, it is more likely to find a high rate of disagreement among members in the choice of a response.

Every disagreement among group members produces essentially two kinds of responses: an explicit response by the majority of the members which is entered on the computer terminal, and an implicit response by the disagreeing member which is not entered on the terminal. Of course, a disagreement may initiate further discussion in an attempt to achieve consensus. If consensus is achieved, the response is entered on behalf of everyone in the group and the resulting feedback applies to each group member.

If consensus is not achieved, the disagreeing member maintains his own implicit response in the face of an explicit alternative response entered by the majority of his group. If, by comparing the feedback to the explicit response with his own implicit response, he finds he was correct, positive reinforcement occurs. In this way, learning may occur among some group members and not others, and this is independent of whether or not the correct response was evaluated by the computer. This may explain the lack of a significant correlation between the criterion test and the number of correct responses in the lessons for groups of two, three, and four people (table 17).

Response Mode

Considerable research has been done to examine the effect of overt versus covert responses on learning. The concensus is that covert responding is as effective as overt responding and, under some conditions, may be superior (Stulorow and Walker, 1962). Other studies have related response mode to such variables as item difficulty, intelligence and long-term versus short-term retention. A review of these studies is found in Smith and Smith (1966).

Basically, a covert response differs from its overt counterpart only in its lack of outward manifestation. The content of each is assumed to be the same. Indeed, when both originate from the same subject, the two are the same. However, in the preceding model of differential interpretation of feedback, the implicit response was held by the disagreeing member, and the explicit response by the remaining members. This means that, insofar as group work is concerned, where implicit and explicit responses are held by different people, their content may be radically different. In fact, in the model, the two differ by definition, since if the two were congruent, there would be no disagreement.

Provision in the model for the holding of an implicit response qualitatively different from the explicit entered response permits a form of simultaneous alternate hypothesis testing. The disagreeing member is, in effect, testing an alternate hypothesis, to be confirmed or rejected indirectly by feedback to his partner's

explicit response. Perhaps this is the feature of group CAI which, more than any other, allows individual learning to take place in groups regardless of the nature of the group response entered on the terminal.

In most studies, the terms "implicit" and "explicit" are often used interchangeably with the terms "covert" and "overt" respectively. Making a distinction between them may prove to be useful, however, as in the present model, by adding a qualitative dimension to response mode to help further differentiate between group and individual learning processes. It is because the response mode may differ qualitatively in the group application, as well as quantitatively, that the terms "covert" and "overt" do not fit comfortably, and the terms "implicit" and "explicit" are preferred.

Classroom Learning and Group CAI

One of the main differences between conventional classroom instruction and individual CAI is that with individual CAI every student is able to make an independent response. With this system, the learner does not remain a passive recipient of information but is active in the learning process. Indeed, this is often one of the claims made on behalf of CAI in order to prove its superiority over conventional classroom instruction. How then, does the group method of CAI differ from the on-going learning of an ordinary

classroom, and what features do group CAI and individual CAI have in common?

In the group CAI method, two features are noted, both of which are characteristics of individual CAI. First, there is opportunity for implicit responding. This is of the utmost importance if implicit rather than explicit responding is the requirement for making feedback effective in the learning process. It is suggested that there is more opportunity for implicit responding under group CAI than in the conventional classroom. Interestingly, however, most teachers intuitively appreciate the value of implicit responding. It is not uncommon to hear teachers ask a pupil a question and, at the same time, instruct all other members of the class to "think" of the answer. Unfortunately, the advantage which small computer-taught groups have over large teacher-taught classes in increased opportunity for implicit responding, may disappear as the computer-taught group increases in size. Further research is needed to ascertain if this is so. It is probable, however, that under CAI conditions the incentive to make implicit responses will always be greater than under conventional classroom conditions.

Second, there is as much opportunity for feedback to each student under group CAI as under individual CAI. Once again, the amount of feedback under either CAI mode exceeds that of a conventional classroom. It has already been explained how, under

group conditions, feedback can be interpreted differently by each group member to enhance learning.

In view of the greater opportunities available under group CAI for discussion, implicit responding, and differentially-interpreted feedback, it is suggested that group CAI does not qualitatively resemble conventional classroom instruction. Clearly, it is more closely associated with other forms of automated teaching in that it encompasses the principles of both programmed instruction and individual computer-assisted instruction. It does not attempt to emulate the processes of conventional large-group classroom instruction, where discussion among students is minimized and opportunities for response are limited.

Group Work, Subject Matter, and Instructional Design

From the results of this study, it would appear that individuals working in groups at CAI terminals learn as much as individuals working alone at CAI terminals. The question could be asked, "To what extent are these findings generalizable to other age groups working on material other than psychology?" One criticism that might originate as a result of any attempt to generalize these findings might be that these results may not apply when learning is undertaken in different subject areas or with different CAI instructional strategies. Two arguments can be advanced, however, to suggest that the successful use of group

CAI is virtually independent of the nature of the subject matter.

The first is the consideration that the instructional strategy employed in the program has already taken into account the type of subject matter. In fact, instructional strategies and subject matter areas are closely interwoven. For example, certain types of material may be presented more effectively using a simulation model, while other types of material may utilize a games approach. It is because a variety of instructional approaches exist that it has often been claimed that virtually any type of subject matter can be programmed. It is quite probable then, that intrinsic differences in subject matter are minimized or eliminated by the choice of an appropriate instructional strategy together with the care and precision involved in educational programming. In this way, the type of instructional strategy employed helps compensate for intrinsic differences in subject matter areas.

For this reason, it is seldom suggested that the nature of the subject matter determines the probability of successful learning under individual CAI. The responsibility rests with the programmer and the instructional paradigms to ensure a high probability of learning with a particular program, and this is independent of subject matter. If the nature of the subject matter does not dictate the probability of successful learning with individual CAI, there seems to be little reason to suspect that it will interfere qualitatively with the presentation of the same program to a small

group. The matter of which instructional design works best with groups is probably a more relevant question and one which warrants further investigation.

A second and more powerful argument to suggest that the effectiveness of group CAI instruction is independent of subject matter, is an empirical one based on past studies of group PI and group CAI using varying instructional paradigms. Subjects in the studies ranged from elementary school to college age, and participated in groups of various sizes. A summary of these studies, indicating subject matter and group size, is found in table 18. In no case were individuals in groups inferior in performance to individuals working independently. It would appear that there is little evidence for concluding that the nature of subject matter is an important variable in determining the degree of success achieved with group CAI.

Attitudes

It had been hypothesized that working together in a small computer-instructed group might reduce the initial frustration and anxiety of being confronted with the operation of a computer terminal. For this reason, it was thought that those who worked together in groups would develop improved attitudes towards CAI in general and that these positive attitudes would be significantly greater than for those who worked alone. The finding was, however,

TABLE 18

SUBJECT MATTER AND GROUP SIZE IN STUDIES OF GROUP PROGRAMMED INSTRUCTION AND COMPUTER-ASSISTED INSTRUCTION

Experimenter	Year	Largest Group	Subject Matter
		Programmed Instruction	
Frye	1963	11	Completing the square and quadratic formula
Farber	1965	4	Executive and Legislative Aspects of Governments
Sawiris	1966c	16	Geometry
Moore	1967	16	Logarithms (did not compare groups with individuals)
Kay, Dodd, and Sime	1968	Class	Not given
Frandsen	1969	4	Principles of Learning in Teaching
Amaria, Biran, and Leith	1969	2	Levers
Amaria and Leith	1969	2	Levers
Hartley and Hogarth	1971	2	Atomic Weights
		Computer-Assisted Instruction	
Grubb	1965	2	Statistics
Goodman	1968	2	Home economics, geography, economics
Love	1969	2	Boolean Algebra
		CAI Gaming	
Karweit and Livingstone	1969	3	Surfboard Manufacturing Game

that there were no significant differences in attitudes among the four treatment groups. Apparently assigning students to work in groups at CAI terminals does not deleteriously affect their attitudes towards CAI as an instructional system. This lends further support to the view that group CAI can be as effective as individual CAI.

It is interesting to note that attitudes towards CAI correlated significantly with scores on the criterion test. This supports the view that the probability of successful learning by a method of instruction is influenced by one's attitude toward that method. Perhaps this is why the correlation of lecture attitude with scores on the criterion test were negative. It would appear that those who favour lectures do not learn as well with CAI.

Personality

It is interesting to note, incidentally, that scores on the the locus-of-control scale were negatively and significantly correlated with age. It would appear that the older a person is, the more likely he is to score at the "internal" end of the scale. It is not known to what extent this finding can be generalized, but further research into this aspect of personality and its relationship to age may establish some degree of generalization. One possible explanation is that for the older students in the

group, the choice of teaching as a profession represented a vertical career decision or a "step upward", achieved only by dint of effort of highly internal individuals. For the younger students, the choice of teaching as a profession represented merely a horizontal career decision and not necessarily an upward move. For them, achievement of their goal did not rest on a high degree of internality. This explanation then, is derived from the biased nature of the sample and does not suggest that individuals become more internal with age.

Attention is drawn too, to the fact that locus-of-control correlated significantly and positively with neuroticism, and was the only personality variable correlated significantly and negatively with age. Although not significant, the relationships between age and all other personality variables (anxiety, extraversion, and neuroticism) show the same negative trend: older students tend to be less anxious, less extraverted, and less neurotic than their younger counterparts. This is only a trend, however, and further research in the area is recommended.

One of the more interesting findings of the study was that scores on such personality variables as extraversion, neuroticism, anxiety, and locus of control, were all unrelated to scores on the criterion test. As might be expected, removing the effect of these personality variables statistically showed no significant differences in mean learning scores among the four treatment

groups. It would appear that personality variables such as these do not affect learning with either individual or group CAI.

This finding raises a number of issues. First, these results are contrary to the studies which suggest that personality variables play an important role in learning, particularly under other instructional methods. On the other hand, they support the view others hold, that at best, personality variables account for only a small percentage of the variance in any set of learning scores.

The fact that none of the four personality measures correlated significantly with learning scores is even more striking when it is considered that three of the five attitude scales (a much less sophisticated test than any of the personality measures) did correlate significantly with learning.

There are several possible explanations which can be advanced to explain this lack of significant relationship between the personality measures and the learning scores. The first is that personality variables are indeed unrelated to learning, and that this finding would emerge only under the highly controlled learning conditions which CAI makes possible.

A second possible explanation is that while the "ideal" or "absolute" personality characteristics of the learner are probably highly correlated with learning, accurate measures of these

characteristics remain to be developed. For those who hold this view, the lack of correlation between learning and existing personality inventories would be expected.

Finally, a third explanation is that CAI as an instructional system minimizes the personality differences among students by means of its attempt at individualization, its well designed instructional strategies, and its carefully planned lesson sequences. If this were the case, differences in personality among students using CAI might well be ignored from an instructional point of view, since these would be overcome by the nature of the instruction. Certainly this would be an ideal for which to strive: the design of an instructional system independent of the personality characteristics of the student users. On a limited basis, CAI may already be such a system, and if so, may well surpass other instructional systems which need to cater to each level of personality on a number of dimensions in order to maintain efficient learning.

Elapsed Lesson Time and On-Line Responses

Before the analysis of elapsed lesson times was undertaken, it was not known if groups would take longer than individuals due to overly long discussion of the material, or if they might be faster due to quick convergence on the correct response. This is an important factor because if four students use one, rather than four terminals, but take four times as long to respond, the cost advantage

in terms of terminal connection time is lost. This would not affect, however, the substantial savings in computer processing time which would occur in proportion to the number of students using each terminal. These savings would be considerable since computer processing time is still a high-cost item in CAI. The analysis of the average group time scores of the three lessons indicated that there were no significant differences among the four groups. The groups of two, three, and four students completed the lessons as quickly as did the students who worked individually.

These results, however, must be interpreted together with the results of the analyses of on-line responses. The fact that the lessons were completed in the same amount of time by the various groups does not necessarily mean that the same processes were involved in their completion. Indeed, it was shown that when the on-line responses made during the course of the lessons were categorized as correct, incorrect, or unrecognizable, that individuals achieved as many correct responses as did those working in groups, but tended to make more incorrect responses, and did make significantly more unrecognizable responses. Summing the types of responses, it was found that individuals made significantly more responses during the lessons than did students working in groups of two, three, or four. Yet no significant differences were found among the groups in either elapsed lesson time or, as reported earlier, in learning. These results suggest that different processes are involved when learning individually with CAI, than when learning

in groups, even though the net result in terms of lesson time and performance on the criterion test is about the same.

Why would individuals working alone make more responses per given unit of time than those who worked together in groups? The answer to this question depends on the nature of the interactions within the learning situation, and the extent to which learning is viewed as a trial-and-error process. One of the difficulties of working alone at a terminal is that the computer often demands a response from the student before the lesson is allowed to progress. This feature is often cited as a benefit of CAI in that it keeps the student active. Thus a student working alone, who does not know the correct response, is required to respond. He may do so by making either a random response or an intuitive guess. If his choice of response happens to be correct, positive reinforcement occurs, and the lesson progresses. If, however, his choice of response is incorrect, he may be branched to a remedial sequence and later encouraged to respond again. The student working alone interacts only with the computer. By leading inevitably to remedial instruction and opportunities for further response, student errors increase the total number of possible responses per lesson. This, of course, is a function of the program design.

Since more responses per unit of time were made by individuals than by groups, it is probable that those responses were of the trial-and-error variety, entered by the student in order to have the lesson

progress, but in fact diverting him to remedial paths.

The group process, however, is qualitatively different. A student in the group who does not know the correct response may discuss it with his colleagues before entering a response on the terminal. For him, interaction is available from both his fellow students and the computer. Discussion within the group may increase the probability of entering correct responses and thereby reduce the number of errors and branches to remedial sequences, and hence the number of responses.

Thus, in comparing the individual and group learning processes in CAI, there are two ways of looking at the lack of significant differences in elapsed lesson time. Considering the group process, it is suggested that the time lost discussing the material is regained by converging on a higher number of correct responses and not having to pursue remedial paths. Or, to put it in other words, in terms of an individual working alone at a terminal, the time gained by making quick, random responses to have the lesson progress is lost by being branched down remedial sequences.

Cost Reduction

From an economic point of view, perhaps the most important aspect of this thesis is the support it lends to cost reduction in CAI through the use of multiple-student terminals. It is an

unfortunate characteristic of our society, however, that decisions affecting education, health, and welfare are often based purely on economic considerations with little or no regard to their social implications. It would be folly to implement group CAI solely on economic grounds without considering the relevant student characteristics which might interact with group size to affect achievement. This is the reason why this study has concentrated on examining student attitudinal, personality and social characteristics with respect to group CAI and has until now minimized possible cost advantages. The cost advantages of group CAI over individual CAI are self-evident. But cost reduction must not be achieved at the expense of the student. Neither can true economic benefits be derived by lowering the overall quality of education.

While it was known that certain major cost advantages would materialize using group CAI, the extent of these was uncertain. It was felt that even if overly long discussion of lesson material among groups increased the amount of terminal connection time, the spread of CPU time and increased terminal connection costs over a larger student base would drastically reduce over-all costs per student.

Analysis of elapsed lesson times, however, indicated that groups of two, three, and four students did not differ significantly from those who worked alone. This means that since terminal connection time is virtually the same for all treatments, cost

reduction per student can be achieved by a factor equal to the size of the group. Costs per lesson do not change, but now a single presentation serves the needs of several students. Executing a lesson once for a group of four students means that the cost of the single execution is shared among four students. Each student in effect pays 25% of the cost. This means an effective cost reduction of 75% per student over individual CAI. Similar savings would apply in the following situations:

Groups of five: savings of 80% per student

Groups of four: savings of 75% per student

Groups of three: savings of 66 2/3% per student

Pairs of students: savings of 50% per student

Other costs normally associated with individual CAI are reduced with group CAI since

1. fewer terminals are required per given number of students.

2. maintenance costs are lower.

3. utilization of existing terminals is more efficient, freeing them for other use.

4. the student capacity of existing terminals is increased.

It should be pointed out that these savings are independent of cost reduction achieved through technological improvement.

Reduced Dehumanization

It has been pointed out that one of the major criticisms of individual CAI is that by isolating the student, dehumanization is brought about. While there are few longitudinal studies to support this contention, little can be said in defence since operational definitions of humanism are lacking. Because there is no social isolation with group CAI, it would appear that the threat of dehumanization is reduced.

All that can be said at the moment is that for those who hold the view that individual CAI is dehumanizing, having students work in small groups around CAI terminals may prove to be a welcome and more acceptable alternative.

Suggestions for Further Research

In discussing the results of the analyses, a number of issues were raised, many of which lend themselves to further investigation.

Motivation and Retention

Neither motivation nor retention was examined specifically in this study, although it was suggested that both may have influenced performance on the criterion test. Future CAI studies may wish to determine whether or not there are any differences in

long-term retention or in motivational levels between individuals working alone and individuals working in groups.

Instructional Design

A. Design of Group Feedback Statements

Further research is recommended to look into the problem of improving feedback statements to capitalize on differential interpretation among group members. This study has suggested that a feedback statement can be interpreted in at least two ways by different group members. It should be possible with some planning to design feedback statements capable of multiple interpretations depending on an individual's original implicit response. It remains to be seen if the number of possible interpretations can be increased to the limit of the group size. This might be accomplished by placing a heavier emphasis on the careful construction of feedback statements. There seems little doubt that, compared with individual CAI, feedback statements in group CAI have added importance, and this necessitates more careful design.

B. Design of Group Programs

The idea of designing better and more efficient feedback statements for use with groups leads naturally to the question of designing whole programs especially for group use. The present study utilized programs originally written for individuals in an

effort to determine if their use with a group was satisfactory. Having established this to be the case, the question remains, "How might an entire program be designed especially for group use to capitalize on the opportunities for interaction within the group and thereby optimize learning?"

One of the features of group work is the high degree of interaction permitted among the group members. Unlike individual CAI, interaction is not limited to student and terminal; neither does the responsibility for providing all the interaction necessary for learning rest entirely with the computer. Having group members interact to help one another learn the material, may make it possible to present larger "chunks" of information per frame to each group. An approach such as this might increase student motivation by stressing the discussion of "issues" rather than single-word responses. As well as resulting in a more challenging form of learning, this kind of large-step feature might also result in shorter and therefore less expensive programs.

A second approach in the design of group programs would be the construction of lesson frames to ensure a high probability of response agreement among group members. This would lessen to some extent the difficult task of designing feedback statements capable of multiple interpretation. It was suggested earlier that where all group members agreed, only a single interpretation of the feedback statement was necessary. Where members disagreed,

multiple interpretation of the feedback statement occurred, based on each student's implicit response, and helped ensure individual learning. The task then, may be one of designing lesson material to ensure high response agreement and thereby lessen the burden on the feedback statement to provide multiple interpretations.

Finally, a third approach to the design of group programs would be to incorporate the opportunity for response by each group member. A single frame could be presented, the material would be discussed, and each student would enter his own individual response. Since several responses would have to be typed in and evaluated separately by the computer this procedure would be somewhat more costly and more time-consuming than the response-by-consensus approach used in this study. Still, the cost would probably be substantially less than with conventional individual CAI. With this system, the student only discusses the material presented by the terminal: he responds independently and in this way maintains response individuality, in a covert fashion.

C. Design of Group Terminals

There seems to be little reason why terminals for groups could not be designed.[3] The possibilities here include multi-screen and/or multi-keyboard terminals. Large screen presentations to

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[3] Carpenter (1970) calls these "pluri-terminals".

conventional size classes using video projectors might also be feasible, if adequate provision for student responses (as in a feedback-classroom) were made. This possibility may be closer than it seems, since many existing CRT terminals provide for a video output to conventional television monitors.

D. Design of Conventional CAI Programs

Among the students assigned to work alone, errors were found to be negatively related to performance on the criterion. This supports much previous research and suggests once again, that for students working independently, frames need to be carefully constructed to increase the probability of correct responses and reduce the occurrence of error responses.

Individualized Instruction

This study has attempted to distinguish between "individual" and "individualized" instruction in the hope of pointing out that what often passes for "individualized" instruction is really just conventional instruction presented on an individual basis. The confusion exists because there remain many questions unanswered, many issues unsettled, and many definitions unclarified, in the complex realm of individualized instruction. Certainly a re-assessment on a theoretical level of "individualized instruction" would not be out of order.

Is truly individualized instruction ever attainable, or must it remain an ideal, forever unreachable? The answer to this question is that instruction which does not take into account the needs and characteristics of the student can hardly be considered individualized. Neither can the simple provision of multiple paths through lesson material coupled with self-pacing meet the criteria of individualized instruction. The goal will remain unreachable as long as the design of instruction continues to ignore the assessed needs of the students.

The question of who is responsible for individualizing instruction has never been answered satisfactorily. The fact is that students have been individualizing their instructional inputs for years, through their choice of courses, by their selective reading, and by "tuning in" to particular lectures and "tuning out" others. It would seem then, that the responsibility for individualizing instruction must be a joint one involving both teacher and student. Hopefully, the educational pendulum will swing back towards the realization that students can and should play a significant role in helping to tailor instruction to their own needs and abilities.

Group Process

From the examination of on-line responses and elapsed lesson times it has been possible to suggest that different learning processes may have been involved when learning individually than when learning in groups. That these different processes actually exist is, at the moment, inference. Further research in the area is recommended. It might be possible to video-tape groups at work in the CAI setting and to later do an interaction analysis in an attempt to confirm the existence of these different learning processes.

Some work might be undertaken to establish the relationship of the group members to the computer terminal. It has been assumed in this study that the role of the computer in the group should be one of teacher. It is possible, however, that other roles exist into which the computer might comfortably fit. The computer might become simply another group member, contributing its specialized potential for information retrieval and logical analysis to the group process. Then too, the computer might assume the role of group leader, gently guiding the progress of problem-solving groups. Some work in this direction has already been undertaken (for example, Joyner and Tunstall, 1970; Tunstall and Joyner, 1971).

Group Composition

A number of issues relating to group composition warrant further investigation.

First, the optimal group size, from a learning viewpoint, has yet to be determined. It was suggested that groups larger than four were unwieldy in this particular application, but that with improved technology, larger groups might be feasible. It is thought, however, that there must be some upper limit to group size beyond which individual learning would deteriorate. This upper limit has yet to be found.

Second, the old issue of determining on which characteristics students should be matched to optimize performance is still with us. It would appear from the present study that personality variables are not the answer. Perhaps students would best be grouped on cognitive style, or other related variables. Intelligence as a classification variable seems to have lost favour due to the stigma associated with being in the "low" group.

Certain attitudes were found to be significantly related to performance, in this study. While it would seem that attitudes toward instruction are unlikely variables for matching students to groups, research could be directed at finding ways of improving the attitudes of group members before instruction begins.

Longitudinal Studies

There are many reasons why longitudinal studies of CAI are few in number. One is that CAI is a relative newcomer to the educational scene. Another is that such studies are always more time-consuming and costly to conduct. These are the principal reasons why most CAI projects tend to be of short duration and cross-sectional in nature. The study by Feldman and Sears (1970) cited in Chapter I is one of the few which examined the social effects of CAI on a long-term basis.

To ascertain the effects of CAI over a long period of time, more longitudinal studies are needed. As a suggestion for further research, a study paralleling that of Feldman and Sears is recommended. The study would be longitudinal in nature and would compare individual and group CAI with respect to the development of socialization among pupils over the course of a school year.

Summary of Findings

The major findings of the study are summarized below:

Learning

1. Individuals in groups of two, three, and four, learned as well from CAI as did individuals working alone.

Attitudes

2. Attitudes towards CAI were not significantly changed as a result of experiencing CAI in groups.

3. Attitudes towards seminars and towards CAI were positively related to performance in CAI, while attitudes towards lectures were negatively related to performance in CAI. There was no significant relationship between attitudes towards tutorials or programmed instruction, and performance in CAI.

4. Attitudes towards various teaching methods did not differentially affect learning among different sized groups.

Personality

5. Extraversion, neuroticism, anxiety, and locus-of-control were all unrelated to performance in CAI. None of these variables interacted with group size to significantly affect learning.

6. Locus-of-control was found to be significantly related to both age and neuroticism. Older students tended to be more "internal" and less neurotic.

On-Line Performance

7. There were no significant differences in elapsed lesson times among the four treatments: groups of two, three, and four

students moved through the lessons as quickly as did individuals.

8. There were no significant differences in the number of correct responses achieved by the various size groups. However, individuals tended to make more errors and did make significantly more total responses than did the larger size groups. Because individuals made more total responses than did groups, over essentially the same period of time, it was suggested that perhaps a different learning process was involved in learning individually than when learning in groups.

9. For individuals, performance on the criterion test was significantly related to the number of correct, incorrect, and unrecognizable responses made during the lesson. For pairs of students, only incorrect and unrecognizable responses were significantly related to performance on the criterion. For groups of three and four students, on-line performance was not significantly related to performance on the criterion.

<u>Cost Reduction</u>

10. In comparison to individual CAI costs, it was found that group CAI operating costs could be reduced by a factor equal to the size of the group utilizing each terminal.

Conclusion

Extending the results of previous research, this study has attempted to determine if individuals in groups larger than two can benefit educationally from group CAI presentations. As well as considering the effect of attitudes and group on-line performance on subsequent individual learning, the study is unique in that it also examined the effects of several personality variables on learning in groups with CAI.

In line with previous research findings, the results of the study suggest that group CAI may prove to be an acceptable and less costly alternative to conventional CAI. A few features of group CAI, some proven, some speculative, are listed below.

Group CAI:

1. is intended as an alternative to, rather than a replacement for, conventional individual CAI.
2. can be implemented on existing systems.
3. is compatible with future technological improvements.
4. is substantially less expensive than conventional CAI.
5. favourably impresses students.
6. can provide individualized instruction.
7. teaches individual students well.
8. may be potentially easier to program.
9. may spur the development of more specialized hardware and software.

10. can contribute to knowledge of the learning process, group interaction, and instructional design.

11. has a research payoff with respect to the easy collection of group data.

12. acts as a catalyst for social interaction, by bringing students together rather than isolating them.

13. may be thought to be less dehumanizing than conventional CAI.

14. can enlarge the role of the computer in education.

15. holds the potential for bridging the gap between individual CAI and conventional classroom instruction.

Education today faces a number of serious issues. One is increasing depersonalization brought about by the trend to larger regional schools, individual timetables, and huge student enrolments. Another is the relentless search for improved instructional techniques. Still another is the upward-spiralling costs of education. There is no single practical answer, but any new methodology which moves towards solving these problems is worthy of consideration. Group CAI is one such method. Ideally, the goal would appear to be a less depersonalizing education with improved instruction and reduced costs. Given the opportunity, computer-assisted group instruction may be able to make some contribution toward this end.

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APPENDICES

Appendix		Page
1	The Survey of Educational Opinions.	157
2	Locus of Control.	181
3	Criterion Test.	186
4	The Teaching Methods Questionnaire II	194
5	Information Questionnaire	201
6	Correlations for the four groups.	203
7	The CAI Lessons	205

APPENDIX 1

The Survey of Educational Opinions

Scores for anxiety are derived from Questionnaire I: "Word Relationships".

Scores for extraversion and neuroticism are derived from Questionnaire III: "Personal Reactions".

FACULTY OF EDUCATION

SURVEY OF EDUCATIONAL OPINIONS

(Do Not Write On This Booklet)

WHAT TO DO:

Inside this booklet are questions designed to discover what your attitudes and interests are. There are no "right" or "wrong" answers: everyone has the right to his own view. To get the best result you will want to answer them honestly. It is YOUR opinion that is important.

Make sure at this point that three answer sheets have been given to you. If not, ask for them now. Print your name and ID number at the top of each sheet in the space provided. Use an HB pencil. If you don't have one ask for one. In the spaces under your age write:-

1. The program you are in (Elementary, Secondary, etc.)

   ____

2. Your major area of teaching concentration

   ____

EXAMPLES:

First, try the three examples to see whether you need to ask anything before starting. When you read the questions in this booklet, you should record your answers on the answer sheets (alongside the same number as in the booklet).

There are different possible answers to each question. Read the questions and mark your answers at the top of the first answer sheet where it reads "Examples". Put a mark between the guidelines as shown ▬ === or === ▬ .

	Yes	No
1. Would you describe yourself as a talkative person?	===	===

(The answering scheme here is: Yes or No)

2. Major questions of national policy should be decided by a referendum.

1	2	3	4	5
===	===	===	===	===

(You are invited to fill in the space according to the scheme:
1 = Strongly Agree; 2 = Agree; 3 = No Opinion;
4 = Disagree; 5 = Strongly Disagree)

3. What aspects of a vacation do you find most attractive? Rank these from 1 to 4.

	1	2	3	4
(a) having new experiences	===	===	===	===
(b) getting away from routine	===	===	===	===
(c) having everything work out	===	===	===	===
(d) meeting interesting people	===	===	===	===

Ask now if anything is not clear. The examiner will tell you when to turn the page and begin the test.

When you answer, keep these three points in mind:-

1. Read carefully the instructions at the head of each Section. Always check the correspondence between the number of the question and the number on the answer sheet.
2. Do not spend too much time pondering the questions. Give the first, natural answer as it comes to you. When in doubt, think of the "average" case, or work in terms of the balance of probabilities in the given situation. You should finish in a little more than an hour.
3. Be sure not to skip anything. Do your best to answer every question. Some may seem personal, but remember that the answer sheets are kept confidential. They can be scored only by use of a special stencil key. Answers to particular questions by individuals are not inspected.

I. WORD RELATIONSHIPS

Below is a list of words printed in capitals. Each is followed by two words in small letters.

		A	B
Example:	SINK	wash	drown

The question is: Does the word SINK make you think of 'wash' more than of 'drown'? Draw a line on the answer sheet to show which word is more connected in your mind with SINK. If you connect 'wash' with SINK, draw a line through the space under A, like this: A B. If you connect 'drown' with SINK, draw a line through the space under B, like this: A B.

Now look at the pairs of words which follow those printed in capitals. On the answer sheet mark A or B to show which word is more connected in your mind with the word in capitals. WORK FAST. Don't stop to think long about any particular word.

(DO NOT OMIT ANY ITEM)

		A	B
1.	SINK	wash	drown
2.	SCISSORS	nurse	cut
3.	WOUND	bandages	feelings
4.	WEIGHT	scale	losing
5.	MAN	work	woman
6.	TROUBLE	lawyer	sorrow
7.	HEAVY	weight	heart
8.	BRING	take	disaster
9.	FAIRY	shameful	wand
10.	LOSE	find	mind
11.	BABY	foundling	little
12.	BITTER	medicine	sweet
13.	THIRST	dry	drink
14.	FOOD	stomach	poisoned
15.	CONTENTED	happy	discontented
16.	SWIFT	hurricane	slow
17.	BOY	girl	mischief
18.	MUTTON	eat	flesh
19.	SLOW	beware	fast
20.	THOUGHTS	ideas	strange
21.	HUNGRY	thirsty	heart
22.	MAN	hard	boy
23.	BLUE	sad	sky
24.	LION	eat	tiger
25.	RIVER	lake	danger
26.	DIGNIFIED	snobbish	poised
27.	EATING	drinking	fasting
28.	STOMACH	food	ache

29.	LIGHT	dark	sentence
30.	TALKED	spoke	about
31.	SLEEP	nightmares	bed
32.	DEEP	ocean	hurt
33.	NEEDLE	drug	sharp
34.	CAN'T	concentrate	fly
35.	FOOT	hand	tingle
36.	FEEL	useless	good
37.	PARTY	crowd	myself
38.	WOMAN	excitement	man
39.	UNHAPPY	no	yes
40.	SHORT	tall	little
41.	GRAVE	serious	funeral
42.	SOUR	lemon	stomach
43.	LEFT	home	right
44.	PINT	quart	whiskey
45.	FRIEND	close	double-crossed
46.	WOMAN	girl	trouble
47.	RAW	deal	meat
48.	SWEET	affected	bitter
49.	LOUD	yell	soft
50.	HANDS	feet	moist

II. ATTITUDES

Read each statement and record your personal opinion in the space provided.

		1	2	3	4	5
If you STRONGLY AGREE	Check 1	▬	___	___	___	___
If you AGREE	Check 2	___	▬	___	___	___
If you can express no opinion	Check 3	___	___	▬	___	___
If you DISAGREE	Check 4	___	___	___	▬	___
If you STRONGLY DISAGREE	Check 5	___	___	___	___	▬

(DO NOT OMIT ANY ITEM)

1. Coloured people are innately inferior.
2. Present laws favour the rich against the poor.
3. War is inherent in human nature.
4. Married women teachers should be barred from working.
5. People with hereditary defects should be sterilized.
6. We treat criminals too harshly; we should try to cure rather than punish them.
7. Our present difficulties are due to moral more than to economic causes.
8. We must give up a large part of our national sovereignty in the interests of peace.
9. Sunday-observance is old-fashioned, and shouldn't govern our behaviour in any way.
10. It is wrong for men to have greater sexual freedom than women.
11. Unrestricted freedom of expression is desirable in the press, in literature, and on the stage.
12. Private property must ultimately be abolished and complete socialism established.
13. During wartime, conscientious objectors are traitors and should be treated accordingly.
14. It is right that comprehensive sex education should be given to all boys and girls at school.
15. Pregnant women should be able to have an abortion if they wish it.
16. Only by returning to religion can civilization hope to survive.
17. Any marriage between a white and a coloured person should be actively discouraged.
18. Jews are just as valuable, honest, and public-spirited citizens as any other group in our community.
19. Major questions of national policy should be decided by reference to majority opinion (e.g. by referendum).
20. There should be far more controversial discussion of real questions on radio and television.

21. The present licensing laws need to be altered to remove restrictions on hours of opening completely.
22. All human beings are born with the same potentialities.
23. Divorce laws need to be altered so as to make divorce easier.
24. Patriotism is a force which works against peace in the modern world.
25. Modern life is too much centred in large cities; the government should encourage a 'return to the country'.
26. Crimes of violence should be punished by flogging.
27. Nationalization of key industries has been shown to lead to inefficiency, bureaucracy, and stagnation.
28. It is right that religious education should be compulsory in state schools.
29. Men and women should have the right to find out whether they are sexually suited before marriage.
30. The principle 'Spare the rod and spoil the child' is a great truth and should be the basis of our method of bringing up children.
31. Women are not equal to men in intelligence or artistic ability.
32. All experiments on living animals should be forbidden.
33. The Jews have too much power and influence in every country.
34. Differences in pay between men and women doing the same work should be abolished in all jobs and professions.
35. Except when medically indicated, birth control should be illegal.
36. The death penalty is barbaric and should be abolished.
37. There will certainly be another world war within the next 25 years.
38. Scientists should not be allowed to take part in politics.
39. The Chinese are by nature a cruel people.
40. Only people with a definite minimum of intelligence and education should be allowed to vote.

III. PERSONAL REACTIONS

You are asked to indicate Yes No or Yes No in answer to each of the following questions.

(DO NOT OMIT ANY ITEM)

1. Do you often act and speak on the spur of the moment?
2. If you wanted to learn something, would you prefer to read a book about it rather than discuss it with an expert?
3. Are you inclined to remain in the background on social occasions?
4. Do you spend a lot of time thinking over the good times you have had in the past?
5. Do you so enjoy opportunities for conversation that you rarely miss a chance of talking to a stranger?
6. In general, do you prefer a well-ordered life with regular hours and an established routine?
7. Are you inclined to be quick and sure in your actions?
8. Would you say that your feelings are rather easily hurt?
9. Do you prefer to take the lead in group activities as a general rule?
10. Do you consider yourself to be tense and 'highly strung'?
11. Would you prefer a job with a secure but modest salary to one with larger but irregular earnings depending on your luck and enterprise?
12. When you are annoyed about anything, do you find it necessary to talk to somebody to 'let off steam'?
13. Are you inclined to be moody?
14. Do you take the initiative in making new friends?
15. Do you hate having to introduce people to each other?
16. Are you much given to telling jokes to your friends?
17. Are you very dependent on sympathetic company to cheer you up?
18. Do you usually 'let yourself go', and have a good time at a party?
19. Have you ever been bothered by useless thoughts which come into your head repeatedly?
20. Do you find it hard to unburden yourself to anyone?
21. Are you often troubled with guilt feelings?
22. Are you happiest when involved in a project which calls for rapid action?
23. Are you inclined to be shy in the presence of the opposite sex?
24. Do you prefer people who keep an open mind to those who know at once where they stand on any issue?
25. Do you always have a 'ready answer' for remarks directed at you?

26. Is your motto to take everyday matters seriously rather than to 'laugh and be merry'?
27. Do you prefer to act rather than to plan for action?
28. Would you describe yourself as a talkative person?
29. Are you usually reserved and distant except with intimate friends?
30. Do you often have a craving for excitement?
31. Do you think you keep in close touch with things going on around you?
32. Do you consider yourself 'happy-go-lucky'?
33. Do you normally limit your acquaintanceship to a select few?
34. Do you often feel unjustly treated?
35. Do you like to be involved in situations where there is plenty of excitement and bustle?
36. Do you often lose sleep by worrying?
37. Would you do almost anything for a dare?
38. Would you describe yourself as rather over-cautious and pessimistic?
39. Would you be strongly averse to selling things or soliciting funds for a good cause?
40. Do ideas run through your head so that often you cannot sleep?

IV. PUNISHMENT

Consider the following statements carefully. Mark the statements you agree with as Yes thus: Yes No. Mark those you disagree with as No thus: Yes No.

(DO NOT OMIT ANY ITEM)

1. I agree with the idea that man's moral nature is such that it cries out for punishment.
2. The Book of Proverbs states the basic truth about punishment: 'He that spareth the rod, hateth his son; but he that loveth him chasteneth him betimes'.
3. More corporal punishment in school and home is needed to offset the corrupting influence of modern civilization.
4. Discipline can never be properly maintained without some form of corporal punishment.
5. If truant children were always strapped, there would be fewer cases of truancy.
6. It is better to deal out a swift, sharp physical punishment than a long drawn-out mental one.
7. The interests of children are best served by punishing them when they have done wrong.
8. Some kind of punishment should be the inevitable result of wrong-doing: this is the basis of moral training.
9. Physical punishment should only be administered when there is a sincere belief that it will be really helpful to the child.
10. Whatever the punishment, it should closely follow the offence.
11. Teachers can do most things with children if they keep their confidence and respect.
12. Children who behave badly need help, not punishment.
13. The best punishment is to make children put right the wrong they have done.
14. Mutual trust is the only possible basis for true discipline.
15. Corporal punishment is not effective as a deterrent.
16. Severe punishment does little good and may do great harm.
17. A school cannot be called an educational establishment if corporal punishment is the main instrument of government.
18. Children brought up under a regime of punishment are probably on the high-road to delinquency.
19. Physical punishment degrades both the teacher and the pupil.
20. It is absolutely wrong for one human being to inflict pain on another.

V. METHOD AND ORGANIZATION

Here are a number of statements concerning the education of young children. Read each statement and express your view of it as follows:-

		1	2	3	4	5
If you STRONGLY AGREE	Check 1	▬	===	===	===	===
If you AGREE	Check 2	===	▬	===	===	===
If you can express no opinion	Check 3	===	===	▬	===	===
If you DISAGREE	Check 4	===	===	===	▬	===
If you STRONGLY DISAGREE	Check 5	===	===	===	===	▬

(DO NOT OMIT ANY ITEM)

1. If a child breaks a school rule he must be made to suffer.
2. Children should be allowed to help each other with their school work in class.
3. The school should not be concerned with imposing standards of behaviour.
4. Children should be allowed to move about the classroom at will.
5. Children must themselves decide what they want to learn.
6. Children should be encouraged to address teachers by their Christian names.
7. Mark lists, when made public, spur children on to greater effort.
8. Corporal punishment is essential for good classroom management.
9. Children should do exactly as they are told without question.
10. Children can only learn what they are interested in.
11. Attendance at school should be voluntary.
12. Moral training must be accorded a place of honour in the time-table.
13. Children should be compelled to participate in games.
14. More stress should be laid on teaching children to spell.
15. A child cannot be expected to write grammatically unless given formal grammar lessons.
16. Children should be made to correct everything they get wrong in their written work.
17. Children should first learn their multiplication tables, then learn how to use them.
18. Geography is best learned from books: field studies are a complete waste of time.
19. The division of the time-table into separate subjects should be discontinued.
20. Religious dogma and doctrine have no place in the school curriculum.

21. We should not bother a child about spelling or grammar unless he asks for help.
22. Children should be compelled to keep their desks tidy.
23. The moral of a story must always be pointed out to young children.
24. History cannot be properly understood unless children learn their dates.
25. Work in school should be arranged entirely on an individual basis.

VI. VALUES

Each of the following questions presents four aspects of a situation. Indicate your order of preference of the alternatives by marking the space for 1(first preference), 2(second preference), 3(third preference) or 4(fourth preference). (Sometimes you may not agree with any of the statements. Remember that you are not asked to agree, but merely to rank them from the best to the worst, according to your personal valuation).

(BE SURE TO PUT A MARK FOR EACH STATEMENT)

In your job as a teacher would you prefer to:-

1. receive approval for doing good work,
2. know that you are helping others,
3. have the satisfaction of completing a long and difficult job,
4. have leisure to do with as you please?

Do you value most:-

5. the teacher you can count on to give you sound advice,
6. the teacher who allows you to work out your own ideas,
7. the teacher who makes the course interesting and unusual for you,
8. the teacher who succeeds in persuading you to master the material covered?

What appeals to you most in life:-

9. to have a variety of interesting experiences,
10. to have authority over people,
11. the certainty of having enough to live on comfortably,
12. the feeling that you are accomplishing something worthwhile?

If you were about to join a club, would you prefer:

13. a group trying to do what it can for those in need,
14. a club where members are free to 'loaf' and to do whatever they want,
15. an organization which protects its members from financial loss,
16. a well-known club of leading people?

What aspects of a vacation abroad would you find most attractive:-

17. meeting congenial fellow travellers,
18. getting away from the restraint and routine of everyday life,
19. having each part of the trip work out just as you planned,
20. running into uncommon and unlooked for adventures?

Which aspects of friendship seem to you most preferable:

21. friends help one to gain influence and run things effectively,
22. friends make it possible to 'go places and do things',
23. friends appreciate your accomplishments and admire what you stand for,
24. friends help you make up your mind before taking an important step?

If you were buying a new car, would you prefer:-

25. one made for safety above all else,
26. one with perfect workmanship and expert construction,
27. one recommended by someone whose judgement you trusted,
28. one specially designed for modernity and style?

If entertaining friends, would you prefer to:-

29. show hospitality and take good care of them,
30. have your friends comment favourably on the unusual features of your living quarters,
31. put your friends at ease by talking with them as soon as possible,
32. steer the conversation along interesting lines?

In what order of preference do you rank the following characteristics:-

33. a high level of skill in doing one job,
34. independence of judgement and acting according to your own standards,
35. friendship and other social qualities that attract people.
36. self-confidence and the ability to command?

Which of the following candidates would you be likely to vote for in an election:-

37. the one who is interested in helping the poor,
38. the steady conservative whose record gives you confidence,
39. the strong leader whom you can trust,
40. the man who is not afraid of breaking with traditional methods?

What do you consider the relative advantages of owning an attractive home:-

41. it brings you prestige and standing,
42. it gives you an inward satisfaction to know you have done a good job of arranging it,
43. it enables you to allow your family and friends to enjoy home comforts,
44. it gives you a feeling of permanence and security?

If you received an unexpectedly large sum of money, would you:-

45. finance a small organization which you could personally direct,
46. invest it in safe shares to provide for your later years,
47. travel to satisfy your curiosity about the rest of the world,
48. entertain your friends and share your pleasures with them?

VII. OPINIONS

A number of controversial opinions about education are expressed in the following statements. Indicate as before whether you agree or disagree in general with each of the opinions:-

		1	2	3	4	5
If you STRONGLY AGREE	Check 1	▬	===	===	===	===
If you AGREE	Check 2	===	▬	===	===	===
If you can express no opinion	Check 3	===	===	▬	===	===
If you DISAGREE	Check 4	===	===	===	▬	===
If you STRONGLY DISAGREE	Check 5	===	===	===	===	▬

(DO NOT OMIT ANY ITEM)

1. Formal correctness in behaviour is less important than spontaneity of expression in children and adults.
2. Direct moral instruction does little to improve the character.
3. Mathematics is valuable for the training it gives in abstract reasoning.
4. We expect too high a standard of literary taste in school.
5. Free activity by children is seldom conducive to good work in the classroom.
6. Some moral standards must be accepted without question.
7. To be really effective, education must be child-centred.
8. The child's needs ought to determine the curriculum.
9. Education should keep high ideals constantly before the children.
10. It is always necessary to make authority seem reasonable to a child.
11. The time to begin to teach reading is when the child feels the need for it.
12. Psychology can add little, if anything, to an experienced teacher's understanding of children.
13. Everything we teach should have a direct bearing on present-day life.
14. Some things are worth learning even though they may seem to have no obvious utility.
15. Parents and teachers should strive <u>not</u> to interfere with the natural development of children.
16. One of the main functions of education is the transmission of our cultural heritage.
17. Fluency of expression should not be cultivated at the expense of correct English.
18. Character training would be impossible if there were no absolute standards of right and wrong.
19. You cannot expect children to write good English if they have no basic knowledge of grammar.
20. The standards of conduct which schools demand of children are generally too high to be realistic.

VIII. CHANGES IN EDUCATION

You are now asked to express an opinion about certain proposed changes in education. Some of these changes may be desirable, others undesirable. Some you may feel unable to express any opinion about.

Consider each of the changes suggested and indicate your opinion as before:-

		1	2	3	4	5
If you STRONGLY AGREE that the change is desirable	Check 1	▬▬▬	===	===	===	===
If you AGREE that the change is desirable	Check 2	===	▬▬▬	===	===	===
If you can express no opinion	Check 3	===	===	▬▬▬	===	===
If you DISAGREE with the change	Check 4	===	===	===	▬▬▬	===
If you STRONGLY DISAGREE with the change	Check 5	===	===	===	===	▬▬▬

(DO NOT OMIT ANY ITEM)

1. Smaller classes.
2. The raising of the school-leaving age to 17 or 18.
3. Spelling reform.
4. Greater use of activity methods.
5. More state control.
6. Increased expenditure on education.
7. Freer discipline.
8. The psychological treatment of juvenile delinquency.
9. Less specialization in the senior high school.
10. More self-government by pupils.
11. Sex education in all secondary schools.
12. A drastic reduction in the number of denominational schools.
13. Abolition of all corporal punishment.
14. Comprehensive schools to be the normal form of secondary education.
15. More nursery schools.
16. A larger proportion of the population to go to universities.
17. More special schools for the subnormal.
18. Compulsory part-time education to 18.
19. More child guidance clinics.
20. Abolition of school cadets and Officers' Training Corps.

IX. MOTIVES

Look at the first section below. It gives four reasons for providing physical education. You may think there are better reasons for having physical education in schools. But consider only the four given. Some are better than others: some you may think are worthless.

Consider each reason and then indicate how good you think it is, by marking:-

		1	2	3	4	5
If you think it is VERY GOOD	Check 1	▬	===	===	===	===
If you think it is FAIRLY GOOD	Check 2	===	▬	===	===	===
If you are in doubt or have no opinion	Check 3	===	===	▬	===	===
If you think it is NOT GOOD	Check 4	===	===	===	▬	===
If you think it is THOROUGHLY BAD	Check 5	===	===	===	===	▬

When you have decided about physical education, look at the reasons for teaching other subjects. Indicate your view of the value of each reason by means of the above system. BE SURE YOU INDICATE YOUR VIEW OF EVERY REASON.

Reasons for Physical Education in Schools:-

1. It develops the child's enjoyment of movement.
2. It makes children responsive to discipline.
3. A fit body is an asset to the nation.
4. It contributes to mental health.

Reasons for teaching English Literature:-

5. It gives you a knowledge of those books which are accepted as good literature.
6. It provides scope for cultivating personal discrimination.
7. An interest in reading can be one of the chief pleasures in life.
8. The imitation of standard works of English literature improves one's style of writing.

Reasons for teaching English Language:-

9. It helps children to express themselves freely and with fluency.
10. It cultivates the enjoyment of language.
11. Children must acquire proficiency in spelling, punctuation and grammar.
12. A person who uses English incorrectly is handicapped in his career.

Reasons for teaching children about religion:-

13. It instils a sense of duty.
14. It helps to keep children from wrong-doing.
15. It develops a sense of spiritual values.
16. The knowledge that there is a loving God meets a deep-felt need.

Reasons for teaching Science:-

17. The sense of wonder is a good starting-point for the development of the child's interests.
18. The study of science satisfies intellectual curiosity.
19. Industry demands an increasing number of workers equipped with scientific techniques.
20. A scientific training offers good career prospects.

Reasons for Education in Citizenship:-

21. It helps to produce a well-informed and critical public opinion.
22. It helps to counteract the dangerous decline in public morality.
23. It teaches young people their obligations to the state.
24. It helps mutual understanding and sympathy.

Reasons for teaching about International Relations:-

25. It nurtures a respect for one's own country and this is the best foundation for one's attitude to other countries.
26. The study of international affairs shows which countries are our friends.
27. Even this kind of intellectual contact between different peoples makes them feel they are alike at heart.
28. Knowing about the achievements of other countries increases our respect for them.

Reasons for excluding Propaganda from Schools:-

29. It is better to aim at sound knowledge and a fair-minded attitude.
30. Pupils should be free to form their own opinions.
31. Propaganda can be misused if it gets into the wrong hands.
32. Instruction in one's duties to the state should come later.

Reasons for favouring Corporal Punishment:-

33. Some children do not respond to any other form of discipline.
34. No other punishment is over so quickly or leaves so little resentment.
35. It is essentially an emergency measure which must be followed by more constructive treatment.
36. The attitude of society towards corporal punishment can only be altered gradually.

Reasons for Probation of Juvenile Offenders:-

37. It is unjust to blame the offender and not the social conditions from which he has suffered.
38. The probation officer may be able to control the offender where others have failed.
39. The serious consequences of a further offence act as an effective deterrent.
40. A period on probation gives an opportunity for re-education.

Reasons for Training Teachers:-

41. The teacher must learn to understand children's needs.
42. The teacher must know how to control children.
43. The teacher must acquire efficient techniques of teaching his subject.
44. The teacher must understand how to develop the children's interest in their studies.

Reasons for Technical Education:-

45. With some children the best approach to education is through their technical interests.
46. Technical school training gives a boy or girl a head start in the competition for jobs.
47. Technical education is a good investment in an industrial country.
48. His future work is one of the main interests of the adolescent.

Reasons for favouring State Control of Education:-

49. Our cultural resources can be safeguarded only if support is given by the state.
50. By means of state control, educational costs can be adjusted so as to satisfy other demands on the nation's resources.
51. The state can ensure that each individual has the special opportunities he needs.
52. The control of social and economic policy demands control of education also.

X. CHOICES

Each statement below is about a topic of interest to teachers. For each item four alternatives are shown. You are asked to mark those alternatives in order of merit, as they appear to you personally. Indicate your order of preference, marking the space for number 1 (first preference), 2(second preference), 3(third preference), 4 (fourth preference) in the boxes provided.

DO NOT OMIT ANY ITEM. Try your best to leave no blanks, however difficult the decision may be.

The study of the Ancient Greeks by the senior class in a secondary school should lay stress on their:-

1. creative achievements in sculpture and drama,
2. interest in games and physical development,
3. interest in science and mathematics,
4. search for the 'good life'.

The School Auditorium or Gymnasium is valuable because it:-

5. provides space for recreation and exercise,
6. absorbs extra classes and is useful for parents' meetings, etc.,
7. makes possible serious work in Drama and Music,
8. enables the school to hold religious services.

The most valuable subject for class discussion would be the life and work of:-

9. Darwin or some other great scientist,
10. Keats or some similar poet,
11. Lister or some other great healer,
12. Luther or some other great religious leader.

We need more nursery classes because they:-

13. ensure that children are properly fed from an early age,
14. release mothers who can be employed in industry,
15. provide the best conditions for a child to learn self-discipline,
16. provide the best approach to the learning processes in very young children.

You would prefer to organize an out-of-school children's club for:-

17. teaching domestic economy,
18. reading plays,
19. doing gymnastics,
20. debating and discussing.

More free activity would be of value in schools because it:-

21. encourages movement and the physical activity which is natural to children,
22. encourages individual spontaneity and creative skill,
23. encourages co-operation and mutual aid amongst children,
24. is a practical way of organizing a class of children of different ages and intelligence levels.

You would send your child to a school noted for its:-

25. success in gaining University scholarships,
26. moral tone,
27. successes on the games field,
28. choral and orchestral work.

Field trips are valuable because they:-

29. give the children a working knowledge of the layout of their neighbourhood,
30. help the teaching of history, nature study and geography,
31. introduce the children to the beauties of nature,
32. get the children into the fresh air.

Teaching children Bible stories is important because it:-

33. enables them to learn the true faith,
34. produces law-abiding citizens,
35. illustrates the principles of ethical reasoning,
36. embodies man's desire for harmony and beauty.

The most desirable quality in a teacher is:-

37. health and energy,
38. sobriety, organization and a sense of purpose,
39. a logical mind,
40. first-hand experience of the working world.

If you were taking a class abroad to study the cathedrals built in earlier times you would point out especially:-

41. the beauty of the stained glass and architecture,
42. the problems and cost of maintenance of these constructions,
43. the history involved,
44. the faith that inspired the builders.

Juvenile delinquency is most likely to be reduced by:-

45. a more efficient system of detection and punishment.
46. the provision of more parks and recreation grounds.
47. the provision of more psychological clinics,
48. compulsory attendance at Sunday School.

If you had to select a visiting speaker, personally unknown to you, for a school talk, you would choose:-

49. an artist,
50. the manager of a supermarket,
51. a research chemist,
52. a missionary.

Which of the following films would you prefer to show a class of boys and girls in school time:-

53. The Life of Christ,
54. A Midsummer Night's Dream (Shakespeare),
55. The Conquest of Everest,
56. A documentary about pollution.

XI. EDUCATIONAL ACTIVITIES

Teaching involves many different activities, most of which are well worth doing. Some you do with great interest, some as reasonable duties, some with little interest. The following list sets out a number of these activities. Respond to each activity as follows:-

		1	2	3
If you consider it to be of GREAT INTEREST	Check 1	▬	===	===
If you consider it to be of AVERAGE INTEREST	Check 2	===	▬	===
If you have LITTLE INTEREST in the task	Check 3	===	===	▬

1. Playing with children.
2. Guiding children across a busy street.
3. Reading, to improve your general knowledge.
4. Trying out new teaching methods.
5. Attending a course on educational principles during the vacation period.
6. Keeping up to date in a special subject.
7. Sympathizing with childish problems which may seem trivial to you personally.
8. Building up your own reference library.
9. Following up the later careers of many of your pupils.
10. Attending a children's party out of school hours.
11. Keeping careful records of the results of your teaching.
12. Acquiring knowledge of a little known subject.
13. Studying for a further academic qualification.
14. Encouraging by special coaching a backward child, not necessarily in your own class.
15. Observing the social relationships in a group of children and making careful records.
16. Giving a series of standardized aptitude tests to a class.
17. Taking a class to the circus.
18. Carefully marking all written work done by a class.
19. Reconsidering your methods of teaching.
20. Attending lectures by experts in your special interest.

APPENDIX 2

Locus of Control

Rotter's (1966) internal-external locus of control scale. Items marked with an asterisk (*) are those common to both the Gurin (1969) and Rotter scales (see Chapter III).

THE I-E SCALE

The following questionnaire is to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered a or b. Please select the one statement of each pair (and only one) which you more strongly believe to be the case as far as you're concerned. Be sure to select the one you actually believe to be more true rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief: obviously there are no right or wrong answers.

Your answers to the items on this inventory are to be recorded on the answer sheet.

Please answer these items carefully but do not spend too much time on any one item. Be sure to find an answer for every choice. Find the number of the item on the answer sheet and black-in the space under the letter a or b which you choose as the statement more true.

In some instances you may discover that you believe both statements or neither one. In such cases, be sure to select the one you more strongly believe to be the case as far as you're concerned. Also try to respond to each item independently when making your choice; do not be influenced by your previous choices.

---

1. a) Children get into trouble because their parents punish them too much.
   b) The trouble with most children nowadays is that their parents are too easy with them.

2. a) Many of the unhappy things in people's lives are partly due to bad luck.
   b) People's misfortunes result from the mistakes they make.

3. a) One of the major reasons why we have wars is because people don't take enough interest in politics.
   b) There will always be wars, no matter how hard people try to prevent them.

4. a) In the long run people get the respect they deserve in this world.
   b) Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

5. a) The idea that teachers are unfair to students is nonsense.
   b) Most students don't realize the extent to which their grades are influenced by accidental happenings.

6. a) Without the right breaks one cannot be an effective leader.
   b) Capable people who fail to become leaders have not taken advantage of their opportunities.

7. a) No matter how hard you try some people just don't like you.
   b) People who can't get others to like them don't understand how to get along with others.

8. a) Heredity plays the major role in determining one's personality.
   b) It is one's experiences in life which determine what they're like.

9.* a) I have often found that what is going to happen will happen.
   b) Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

10. a) In the case of the well prepared student there is rarely if ever such a thing as an unfair test.
    b) Many times exam questions tend to be so unrelated to course work that studying is really useless.

11. a) Becoming a success is a matter of hard work, luck has little or nothing to do with it.
    b) Getting a good job depends mainly on being in the right place at the right time.

12. a) The average citizen can have an influence in government decisions.
    b) This world is run by the few people in power, and there is not much the little guy can do about it.

13.* a) When I make plans, I am almost certain that I can make them work.
    b) It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune tomorrow.

14. a) There are some people who are just no good.
    b) There is some good in everybody.

15.* a) In my case getting what I want has little or nothing to do with luck.
b) Many times we might just as well decide what to do by flipping a coin.

16. a) Who gets to be the boss often depends on who was lucky enough to be in the right place first.
b) Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.

17. a) As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.
b) By taking an active part in political and social affairs the people can control world events.

18. a) Most people don't realize the extent to which their lives are controlled by accidental happenings.
b) There really is no such thing as "luck".

19. a) One should always be willing to admit mistakes.
b) It is usually best to cover up one's mistakes.

20. a) It is hard to know whether or not a person really likes you.
b) How many friends you have depends upon how nice a person you are.

21. a) In the long run the bad things that happen to us are balanced by the good ones.
b) Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22. a) With enough effort we can wipe out political corruption.
b) It is difficult for people to have much control over the things politicians do in office.

23. a) Sometimes I can't understand how teachers arrive at the grades they do.
b) There is a direct connection between how hard I study and the grades I get.

24. a) A good leader expects people to decide for themselves what they should do.
b) A good leader makes it clear to everybody what their jobs are.

25.* a) Many times I feel that I have little influence over the things that happen to me.
b) It is impossible for me to believe that chance or luck plays an important role in my life.

26. a) People are lonely because they don't try to be friendly.
    b) There's not much use in trying too hard to please people, if they like you, they like you.

27. a) There is too much emphasis on athletics in high school.
    b) Team sports are an excellent way to build character.

28.* a) What happens to me is my own doing.
    b) Sometimes I feel that I don't have enough control over the direction my life is taking.

29. a) Most of the time I can't understand why politicians behave the way they do.
    b) In the long run the people are responsible for bad government on a national as well as on a local level.

APPENDIX 3

Criterion Test

CRITERION TEST

1. Suppose a cat on whom a brain operation has been performed learned the following two experimental behaviours:

   1) to touch a red rather than a white square to obtain food when its right eye is covered and its left eye is open;
   2) to touch the white rather than the red square to obtain food when its left eye is covered and its right eye is open.

   What characteristics of sensory and motor pathways in the nervous system is demonstrated by this evidence?

   a. parallel conduction
   b. point-to-point projection
   c. divergent conduction
   d. lateralization
   e. all-or-none principle

2. Auditory reception of sounds and noises would first be sent through the nervous system to the area of the cortex known as

   a. the association area
   b. the motor area
   c. the somesthetic area
   d. the sensory area

3. A dendrite conducts impulses

   a. toward a muscle
   b. away from a receptor
   c. away from a cell body
   d. toward a cell body

4. The nerve impulses from feeling an ice-cube pressed against your neck would first be sent to the area of the cortex called

   a. association area
   b. frontal lobe
   c. somesthetic area
   d. occipital lobe

5. An injury to the cortex which produces loss of touch perception in the left foot must have been in the

   a. left motor area
   b. right somesthetic area
   c. right motor area
   d. left somesthetic area

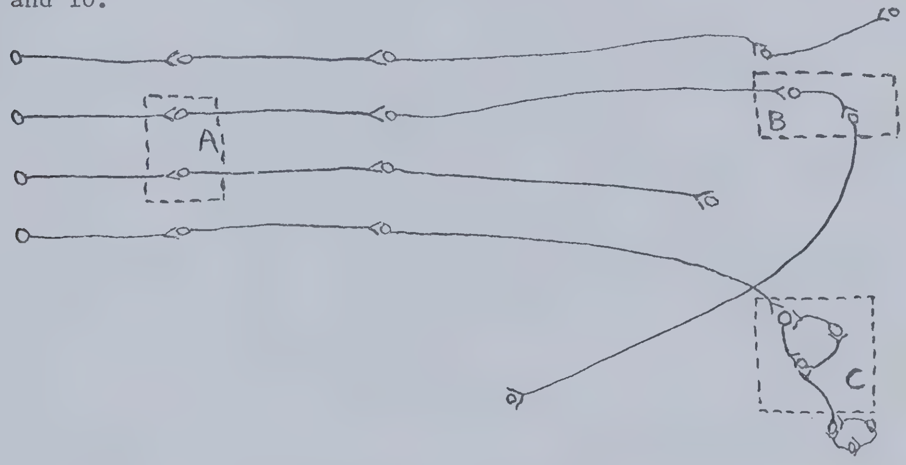
6. What characteristic of parallel conduction makes it a reliable method of neural transmission?

   a. many fibers are leading in the same direction
   b. increased chances of summation
   c. parallel fibers fire at different times

7. Which of the following is NOT a characteristic of cell assemblies?

   a. reverberating circuit
   b. a theory of how mediating processes work
   c. dependent on parallel conduction
   d. a closed, re-entrant loop

Study the diagram that follows noting areas indicated by the letters A, B, and C. Use the diagram to answer questions 8, 9, and 10.



8. Summation is most likely to occur in

   a. area A
   b. area B
   c. area C
   d. none of the indicated areas.

9. Parallel conduction is shown in

   a. area A
   b. area B
   c. area C
   d. none of the indicated areas.

10. Cell assemblies are depicted in

    a. area A
    b. area B
    c. area C
    d. none of the indicated areas.

11. In an experiment on the effects of pollution, a subject is seated in a small room in front of a screen. Various pictures are shown on the screen for 10-second intervals. One picture is of the rear of a large bus. Immediately following this picture, a small whiff of diesel exhaust is blown into the room. The subject first coughs, then holds his breath. After several times, the exhaust is no longer blown into the room, but the subject coughs and holds his breath after seeing the bus picture anyway.
    Is the coughing behaviour of the subject

    a. sense-dominated behaviour
    b. reflexive behaviour
    c. higher behaviour involving mediating processes
    d. sense-dominated, reflexive behaviour

12. Identify the CS (conditioned stimulus) in the above:

    a. initial coughing behaviour
    b. diesel exhaust
    c. bus picture
    d. final coughing behaviour

13. Identify the UCS (unconditioned stimulus) in the above:

    a. initial coughing behaviour
    b. diesel exhaust
    c. bus picture
    d. final coughing behaviour

14. Identify the CR (conditioned response) in the above:

    a. initial coughing behaviour
    b. diesel exhause
    c. bus picture
    d. final coughing behaviour

15. Identify the UCR (unconditioned response) in the above:

    a. initial coughing behaviour
    b. diesel exhaust
    c. bus picture
    d. final coughing behaviour

16. A man in a noisy office stops briefly and listens closely to hear a news report on a small radio across the room. This behaviour is an example of

    a. reflexive behaviour
    b. immediacy
    c. constancy
    d. selectivity

17. A pattern of mental expectation is known as

    a. attention
    b. set
    c. selectivity
    d. immediacy

18. Immediacy and constancy are two factors which suggest

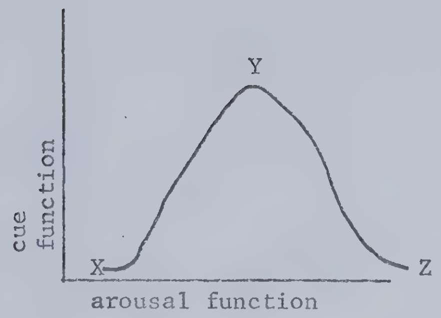
    a. the existence of cell assemblies
    b. an indirect path running from receptors to effectors
    c. a deficit in parallel conduction
    d. mediation
    e. a direct path running from receptors to effectors

19. The singer in a rock band gets a shock from the microphone at the instant his bass guitarist hits a low "E" note. The shock causes the singer's hair to stand on end. This happens several times. An electrician fixes the problem, but he doesn't get a chance to tell the singer. The bass guitarist hits another low "E" note and although there is no shock, <u>the singer's hair stands on end anyway</u>.
The underlined behaviour is an example of _________ behaviour.

    a. mediated
    b. reflexive
    c. attentional
    d. set

20. In the above example the low "E" note is the

    a. UCS
    b. UCR
    c. CS
    D. CR



For each of the following statements, indicate whether the person described is in a state represented by point X, Y, Z, or none of those points, on the curve in the diagram.

21. A person relaxing on a weekend is very busy with his hobby - he is repairing the mechanism of old clocks, which he does with great skill.

    a. point X
    b. point Y
    c. point Z
    d. none of those points.

22. A student taking an important exam becomes very anxious and upset because of the difficulty of some questions and is therefore unable to finish the exam. He later discovers that in doing so, he has missed several questions to which he knows the answers well.

    a. point X
    b. point Y
    c. point Z
    d. none of those points.

23. A person who has just awakened fumbles for his alarm clock but has difficulty turning off the alarm.

    a. point X
    b. point Y
    c. point Z
    d. none of those points.

24. Suppose that during an outing in the woods a physician was forced to perform a delicate operation on a member of his family. He is very worried and has difficulty during the operation. For this situation state whether cue function

24. (cont'd.)

and motivation (as defined by Hebb) would be at a high or a low level.

a. physician's cue function high, motivation high
b. physician's cue function low, motivation high
c. physician's cue function high, motivation low
d. physician's cue function low, motivation low

25. The general excitation from the arousal system helps higher functions such as mediating processes to occur by providing

a. motivation
b. divergent conduction
c. summation
d. cue function

26. Suppose a woman is very worried about her husband who is late arriving home from an automobile trip on a snowy day. While waiting, she prepares his favourite gourmet dinner, but drops the main course on the kitchen floor.
For this example, indicate which of the following would be operating:

a. high motivation to prepare dinner, high emotional excitation
b. high motivation to prepare dinner, low emotional excitation
c. low motivation to prepare dinner, high emotional excitation
d. low motivation to prepare dinner, low emotional excitation.

27. Cortical functions including mediating processes are most effective at arousal levels which are:

a. low
b. moderate
c. high
d. all of the above.

28. Arousal and cue function are both associated with

a. afferent sensory paths
b. mediation
c. point-to-point projection
d. lateralization
e. none of the above.

29. Specific afferents are associated with the ______________, while non-specific afferents are associated with the ______________.

    a. cell assembly system, arousal system
    b. arousal system, sensory cortex
    c. sensory cortex, cell assembly system
    d. arousal system, cell assembly system

30. Selective attention is made possible by

    a. parallel conduction
    b. reverberating circuits
    c. cell assembles
    d. both b and c above
    e. none of the above.

APPENDIX 4

The Teaching Methods Questionnaire II

TEACHING METHODS QUESTIONNAIRE II

It is not easy to give clear, unequivocal definitions of the various methods of instruction use in higher education, because practice varies a good deal. The definitions found on the following pages are given to clarify the way in which it is proposed to use terms in this investigation.

INSTRUCTIONS

On each of the following pages is found a definition of a teaching method followed by ten statements about that method.

Read each of the statements carefully and indicate your view of them as follows:

A	a	d	D
Strongly Agree	agree	disagree	Strongly Disagree

USE THE ANSWER SHEET PROVIDED - USE ONLY AN HB PENCIL

Use the pencil to shade in the area representing your choice: "A" if you strongly agree with the statement; "a" if you agree; "d" if you disagree; and "D" if you strongly disagree.

Remember to fill in your name and student number in the places provided at the top of the answer sheet.

Answer the items pertaining to your sex and your experience in each of the items.

BE SURE TO ANSWER EVERY ITEM. DO NOT LEAVE ANY BLANKS.

DO NOT MAKE ANY UNNECESSARY MARKS ON THE ANSWER SHEET.

CHECK YOUR SHEET BEFORE YOU HAND IT IN TO MAKE SURE YOU HAVE

ANSWERED EVERY ITEM.

The lecture is taken to mean a discourse which is given to a large or small group of students, with minimal interruption, the students being expected to make notes of anything that may be of use to them.

L.1.	The lecture is the most effective method of teaching in higher education.	A	a	d	D
L.2.	Lecture courses are not only important but are in fact indispensable.	A	a	d	D
L.3.	A garbled or otherwise poor lecture is a fairly common experience in higher education.	A	a	d	D
L.4.	Unnecessary time is wasted in lectures to provide information more easily obtained from other sources	A	a	d	D
L.5.	The advantages of a systematic, organized lecture course outweigh the negative features of this teaching method.	A	a	d	D
L.6.	The lecture does not usually involve sufficient active participation by the student.	A	a	d	D
L.7.	There is no adequate substitute for lecture courses.	A	a	d	D
L.8.	Students come to place too great reliance on the lecturer and to avoid individual study and reading.	A	a	d	D
L.9.	Creativity and initiative on the part of the student are normally reduced by reliance on lecture courses.	A	a	d	D
L.10.	Attendance at lectures provides the student with the frame of reference essential to the given subject.	A	a	d	D

The tutorial covers a wide range of practices, such as individual tutorial and supervision (Oxford and Cambridge), small group tutorials, etc. The tutor is normally expected to direct the course of the discussion. The group may discuss previous lectures or raise questions about a required text or assignment; the tutor deals with any difficulties, stimulates interest for further study and tests the student's understanding in an informal way.

T.1.	The practice of assigning a student to a tutor or supervisor should be established universally.	A	a	d	D
T.2.	Tutorials are a luxury in higher education, only appropriate in the special conditions of Oxford and Cambridge.	A	a	d	D
T.3.	The tutorial system is probably the prime cause of the prestige and success of the older English Universities.	A	a	d	D
T.4.	The staff-student ratio involved in the individual tutorial system makes it impracticable as a teaching method.	A	a	d	D
T.5.	The individual tutorial is extremely wasteful of the teacher's time.	A	a	d	D
T.6.	The weekly tutorial promotes regular guidance of the student, this being one of the most important duties of academic staff.	A	a	d	D
T.7.	In practice, a great number of tutors monopolize the time available for tutorial discussion.	A	a	d	D
T.8.	Tutorial provide the students with detailed knowledge of the expectations and demands of their society.	A	a	d	D
T.9.	In the tutorial, students have the greatly-to-be-desired opportunity of personal contact with their teachers.	A	a	d	D
T.10.	The individual tutorial is too exacting for the great majority of students.	A	a	d	D

The seminar involves the tutor in handing over many of his traditional roles to other members of the group. In particular, students take it in turn to act as discussion leader.

S.1.	Seminars should invariably form an important part of the curriculum.	A	a	d	D
S.2.	Seminars are a waste of time which could be used more effectively with another method of teaching.	A	a	d	D
S.3.	Seminars, although perhaps informative at a certain level, cannot be accepted as a teaching method.	A	a	d	D
S.4.	In a seminar, the teacher can learn about his subject as well as teaching it.	A	a	d	D
S.5.	Seminars, unless compulsory, are not useful because students soon lose interest.	A	a	d	D
S.6.	A student-oriented seminar provides a sound learning situation.	A	a	d	D
S.7.	In a seminar, students have the opportunity of seeing their subject from several points of view.	A	a	d	D
S.8.	Students tend to take seminars as routine affairs once they have had their 'turn'.	A	a	d	D
S.9.	Teaching by seminar gives the student an opportunity to show his capacity for original work.	A	a	d	D
S.10.	In a seminar students fall into fallacious arguments and other harmful ways of thinking.	A	a	d	D

<u>Programmed instruction</u> involves the presentation of lesson material to students in an organized series of pre-planned small steps. Opportunity is given for student response and mastery of concepts permits continuation of the lesson. Non-mastery directs the student to remedial steps or further explanation. Programmed lessons are usually presented by simple teaching machines or scrambled textbooks.

P.1.	Programmed instruction does not work in some subjects.	A	a	d	D
P.2.	Most students enjoy programmed instruction and learn well this way.	A	a	d	D
P.3.	Programmed instruction removes too much of the truly "personal touch" in education.	A	a	d	D
P.4.	Teachers could improve their teaching by using more programmed instruction.	A	a	d	D
P.5.	Programmed instruction is good only for "pure memory work" and fact to be learned by rote.	A	a	d	D
P.6.	Any subject, if properly organized, is good material for programmed instruction.	A	a	d	D
P.7.	Programmed instruction can give more individualized teaching to a class of 30 than can a typical teacher.	A	a	d	D
P.8.	Learning by programmed instruction is usually a very boring experience.	A	a	d	D
P.9.	Critical thinking cannot be taught through programmed instruction.	A	a	d	D
P.10.	Programmed instruction can teach values satisfactorily.	A	a	d	D

Computer-assisted instruction is similar to programmed instruction in that students respond to small steps of lesson material. The presentation, however, is controlled by a computer and presented by a remotely-controlled typewriter, visual, or audio terminal. The use of the computer provides much flexibility in lesson presentation and in assessment of student performance.

C.1.	Computer-assisted instruction will probably never become frequently used in most school systems.	A	a	d	D
C.2.	The best computer-assisted instruction could never replace even mediocre teachers.	A	a	d	D
C.3.	Computer-assisted instruction could be used to relieve a teacher shortage, should one occur.	A	a	d	D
C.4.	Computer-assisted instruction removes an essential element from education - humanity.	A	a	d	D
C.5.	Computer-assisted instruction will certainly become more widely used and useful in education.	A	a	d	D
C.6.	Students learn better from "live" teachers than from computer-assisted instruction.	A	a	d	D
C.7.	Computer-assisted instruction is no more cold and impersonal than are textbooks.	A	a	d	D
C.8.	Computer-assisted instruction encourages the student to cheat or do anything to get on to the next question.	A	a	d	D
C.9.	Computer-assisted instruction can be very helpful in teaching almost any subject.	A	a	d	D
C.10.	Computer-assisted instruction can free the teacher's time for more creative teaching.	A	a	d	D

APPENDIX 5

Information Questionnaire

INFORMATION QUESTIONNAIRE

Name ____________________ Number (6 digits) ____________

ANSWER THIS SECTION ON THE BOTTOM OF THE ANSWER SHEET WHICH IS LABELLED PART "2". Use answer 1 to 15 as needed.

1. How many people were in your group?
   a. one
   b. two
   c. three
   d. four

2. What would you think is the ideal number for a group involved with this kind of learning on a computer terminal?
   a. one
   b. two
   c. three
   d. four
   e. five or more

3. How much lesson material would you estimate you learned?
   a. very little
   b. little
   c. much
   d. very much

4. Estimate your amount of participation in the formulation of responses for the computer.
   a. very little
   b. little
   c. much
   d. very much

5. In your group, did you actually operate the computer terminal for any appreciable amount of time during the three lessons?
   a. yes
   b. no

6. Did you take all three of the lessons and the fourth evaluation session roughly one week apart? (give or take a day each week)
   a. yes
   b. no

7. Were all your group members present for each lesson?
   a. yes
   b. no

Your comments are important. If you have any thoughts on computer-assisted instruction in general (not about the lessons) please add them below. Thanks. (Use the back if necessary)

Comments:

APPENDIX 6

Pearson Product-Moment Correlations for Age, Criterion Test Scores and Personality Variables for Each of the Four Treatment Groups

PEARSON PRODUCT-MOMENT CORRELATIONS FOR AGE, CRITERION TEST SCORES AND PERSONALITY VARIABLES FOR EACH OF THE FOUR TREATMENT GROUPS

Variable	Group Size	2	3	4	5	6	7
1. Age	1	.007	-.242[1]	-.069	-.177	-.195	-.229[1]
	2	-.023	-.119	-.082	.007	.022	.332[2]
	3	.208	-.005	-.025	-.119	-.031	-.134
	4	-.049	-.213	-.150	-.111	-.049	-.162
2. Criterion	1		.097	-.050	-.043	.005	.054
	2		-.125	-.041	.072	.042	-.069
	3		.206	-.030	.027	.154	-.036
	4		.037	.020	.007	.158	.028
3. Rotter's Locus of Control	1			.703[3]	.005	-.014	.158
	2			.757[3]	.008	-.165	.032
	3			.696[3]	.083	-.017	.234[1]
	4			.748[3]	.084	.112	.160
4. Gurin's Personal Locus of Control	1				.010	-.043	.258[1]
	2				.024	-.036	.130
	3				.084	-.021	.191
	4				.080	-.001	.101
5. Anxiety	1					-.112	.348[2]
	2					-.035	.178
	3					.014	.287[2]
	4					.182	.210
6. Extraversion	1						-.092
	2						.062
	3						-.107
	4						.030
7. Neuroticism							

[1] $p < .05$; [2] $p < .01$; [3] $p < .001$

APPENDIX 7

The CAI Lessons

1. Sample of MULE lesson coding (from lesson 2).
2. Sample student terminal session (from lesson 2).
3. Diagrams accompanying the three CAI lessons.

SAMPLE OF MULE LESSON CODING

```
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
    PRE     MODES OF SENSORY CONTROL:  HIGHER AND LOWER BEHAVIOR
    PRE THE LESSON POSES THE QUESTION:  WHEN IS MAN ACTING IN DIRECT
    XXX RESPONSE TO STIMULI FROM THE ENVIRONMENT, AND WHEN DOES HE
    XXX ACT "VOLUNTARILY"?
    XXX OBJECTIVE:  THE STUDENT WILL BE ABLE TO DISTINGUISH BETWEEN
    XXX BEHAVIOR THAT IS UNDER DIRECT SENSORY CONTROL AND BEHAVIOR
    XXX THAT HAS HIGHER LEVEL THOUGHT PROCESSES INTERVENING BETWEEN
    XXX STIMULI AND RESPONSE.
    PRO SOME HUMAN BEHAVIOR RESULTS FROM DIRECT NEURAL CONNECTIONS
    XXX BETWEEN SENSORY STIMULATION AND MUSCLE RESPONSE.  OTHER
    XXX BEHAVIOR INVOLVES "THINKING" AND DELAYS BETWEEN STIMULUS AND
    XXX --------.
    ANS
    GUD RESPONSE
    XXX YES, RESPONSE.
    GUD MUSCLE RESPONSE
    XXX RIGHT, RESPONSE.
    UNX 1
    XXX RESPONSE -- YOU KNOW, THE OLD S-R COMBINATION
    PRO FOR EXAMPLE, A TOPLESS DANCER AT A DISCOTHEQUE SUDDENLY GETS
    XXX A DRAFT OF COLD AIR AND SHE SHIVERS.  IS HER SHIVERING A
    XXX RESULT OF A DIRECT OR AN INDIRECT CONNECTION BETWEEN COLD
    XXX AIR STIMULUS AND RESPONSE
1   ANS
    GUD DIRECT
    XXX YES, DIRECT.  SHIVERING IS A REFLEXIVE RESPONSE.
    BAD INDIRECT
    XXX NO, DIRECT.  SHIVERING IS A REFLEXIVE RESPONSE WHICH COMES
    XXX IMMEDIATELY AFTER THE COLD AIR STIMULUS.
    UNX 1
    XXX DIRECT OR INDIRECT?  PLEASE ANSWER AGAIN.
    GTO 1
    UNX 1
    XXX ANSWER IS DIRECT.  SHIVERING IS A DIRECT (REFLEXIVE)
    XXX RESPONSE WHICH IMMEDIATELY FOLLOWS THE COLD AIR STIMULUS.
    XXX NO "THOUGHT" OCCURS.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
    PRO THE TWO MAIN CATEGORIES OF BEHAVIOR THEN, ARE 1) SENSE
    XXX DOMINATED OR REFLEXIVE BEHAVIOR AND 2) HIGHER BEHAVIOR
    XXX INVOLVING --------- PROCESSES.
3   ANS
    GUD MEDIATING
    XXX YES, VERY GOOD
    UNX 1
```

```
XXX WE WERE THINKING OF A WORD THAT MEANS "GOES BETWEEN".
XXX TRY AGAIN.
GTO 3
UNX 1
XXX MEDIATING.
PRE BUT WHAT ARE MEDIATING PROCESSES?  HOW CAN WE BE CERTAIN OF
XXX DISTINGUISHING BETWEEN HIGHER AND LOWER BEHAVIOR?
PRE IN ORDER TO STUDY CONNECTIONS BETWEEN STIMULI AND RESPONSE
XXX WE NEED SOME NEW TERMINOLOGY.  THE FOLLOWING ARE TERMS FIRST
XXX USED BY PAVLOV IN HIS EXPERIMENTS ON CONDITIONING IN DOGS:
XXX CS :  CONDITIONED STIMULUS
XXX UCS:  UNCONDITIONED STIMULUS
XXX CR :  CONDITIONED RESPONSE
XXX UCR:  UNCONDITIONED RESPONSE
XXX IF YOU WOULD LIKE A QUICK REVIEW OF THESE TERMS TYPE "YES".
XXX OTHERWISE TYPE "NO" AND YOU WILL SKIP THE REVIEW.
4   ANS
GUD YES
XXX O.K. HERE'S A REVIEW.
GTO 5
BAD NO
XXX O.K. HERE'S AN EXAMPLE WHERE THESE TERMS ARE USED.
GTO 6
UNX 3
XXX WHAT?  ANSWER YES IF YOU WANT THE REVIEW, NO IF YOU DON'T.
GTO 4

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
PRE END OF LESSON 2.  THANKS FOR YOUR SELECTIVE ATTENTION.  SEE
XXX YOU AGAIN SOON
SHO YOU GOT;#1; ANSWERS CORRECT,
SHO AND;#2; ANSWERS INCORRECT
SHO AND;#0; ANSWERS "UNEXPECTED"
PRE NOTE:  TO RECEIVE CREDIT FOR THIS LESSON FOLLOW THESE
XXX INSTRUCTIONS:
XXX 1.  AFTER SIGNING OFF ACCORDING TO YOUR INSTRUCTIONS,
XXX 2.  TEAR OFF THIS PAGE WITH THE COMPLETE LESSON,
XXX 3.  SIGN THE BOTTOM OF IT, AND
XXX 4.  DEPOSIT IT IMMEDIATELY IN THE BOX BY THE DOOR.
PRE IF YOU HAVE ANY COMMENTS ABOUT THE LESSON OR THE SYSTEM
XXX PLEASE WRITE THEM IN BELOW:
XXX THANK YOU.
PRE COMMENTS:
PRE
PRE SIGNATURE(S) ----------------------STUDENT ID------------
PRE              ----------------------          ------------
PRE              ----------------------          ------------
PRE              ----------------------          ------------
END
```

SAMPLE STUDENT TERMINAL SESSION

. . . .
HOW MANY PEOPLE IN YOUR GROUP? TYPE IN ONE DIGIT. E.G. 1,2,3, OR 4
?
3

PLEASE TYPE IN YOUR GROUP NUMBER I.E. THE FIRST THREE DIGITS
?
317
HI, KATHY, ROY, AND VALERIE!

IT'S GOOD TO SEE YOU AGAIN. HERE ARE YOUR INSTRUCTIONS.
ALL THREE OF YOU WILL BE WORKING TOGETHER ON THIS LESSON. EACH OF YOU SHOULD READ CAREFULLY WHAT I TYPE. EVERY SO OFTEN I WILL ASK A QUESTION FOLLOWED ON THE NEXT LINE BY A "?". THIS IS YOUR SIGNAL THAT I AM WAITING FOR YOUR ANSWER. YOU MAY DISCUSS THE MATERIAL AMONG YOURSELVES, AND AMONG YOU DECIDE ON THE CORRECT ANSWER. ONE OF YOU SHOULD BE DESIGNATED TO TYPE IN THE RESPONSE, FOLLOWED BY "CRTL-Q". I WILL LET YOU KNOW IF YOU ARE RIGHT. REMEMBER, YOU MAY TYPE IN ONLY ONE ANSWER EVEN IF ONE OR TWO OF YOU DO NOT AGREE. TRY TO DECIDE ON ONE ANSWER AND TYPE IT IN. (FLIP A COIN TO DECIDE IF YOU HAVE TO).

MODES OF SENSORY CONTROL: HIGHER AND LOWER BEHAVIOR

THE LESSON POSES THE QUESTION: WHEN IS MAN ACTING IN DIRECT RESPONSE TO STIMULI FROM THE ENVIRONMENT, AND WHEN DOES HE ACT "VOLUNTARILY"?
OBJECTIVE: THE STUDENT WILL BE ABLE TO DISTINGUISH BETWEEN BEHAVIOR THAT IS UNDER DIRECT SENSORY CONTROL AND BEHAVIOR THAT HAS HIGHER LEVEL THOUGHT PROCESSES INTERVENING BETWEEN STIMULI AND RESPONSE.

SOME HUMAN BEHAVIOR RESULTS FROM DIRECT NEURAL CONNECTIONS BETWEEN SENSORY STIMULATION AND MUSCLE RESPONSE. OTHER BEHAVIOR INVOLVES "THINKING" AND DELAYS BETWEEN STIMULUS AND --------.
?
RESPONSE
YES, RESPONSE.

FOR EXAMPLE, A TOPLESS DANCER AT A DISCOTHEQUE SUDDENLY GETS A DRAFT OF COLD AIR AND SHE SHIVERS. IS HER SHIVERING A RESULT OF A DIRECT OR AN INDIRECT CONNECTION BETWEEN COLD AIR STIMULUS AND RESPONSE

?
INDIRECT
NO, DIRECT. SHIVERING IS A REFLEXIVE RESPONSE WHICH COMES
IMMEDIATELY AFTER THE COLD AIR STIMULUS.

. . . .
THE TWO MAIN CATEGORIES OF BEHAVIOR THEN, ARE 1) SENSE
DOMINATED OR REFLEXIVE BEHAVIOR AND 2) HIGHER BEHAVIOR
INVOLVING --------- PROCESSES.
?
WE ARE NOT SURE
WE WERE THINKING OF A WORD THAT MEANS "GOES BETWEEN".
TRY AGAIN.
?
MEDIATING
YES, VERY GOOD

BUT WHAT ARE MEDIATING PROCESSES? HOW CAN WE BE CERTAIN OF
DISTINGUISHING BETWEEN HIGHER AND LOWER BEHAVIOR?

IN ORDER TO STUDY CONNECTIONS BETWEEN STIMULI AND RESPONSE
WE NEED SOME NEW TERMINOLOGY. THE FOLLOWING ARE TERMS FIRST
USED BY PAVLOV IN HIS EXPERIMENTS ON CONDITIONING IN DOGS:
CS : CONDITIONED STIMULUS
UCS: UNCONDITIONED STIMULUS
CR : CONDITIONED RESPONSE
UCR: UNCONDTITIONED RESPONSE
IF YOU WOULD LIKE A QUICK REVIEW OF THESE TERMS TYPE "YES".
OTHERWISE TYPE "NO" AND YOU WILL SKIP THE REVIEW.
?
NO
O.K. HERE'S AN EXAMPLE WHERE THESE TERMS ARE USED.

. . . .
END OF LESSON 2. THANKS FOR YOUR SELECTIVE ATTENTION. SEE
YOU AGAIN SOON
YOU GOT 23 ANSWERS CORRECT,
AND 9 ANSWERS INCORRECT
AND 3 ANSWERS "UNEXPECTED".

NOTE: TO RECEIVE CREDIT FOR THIS LESSON FOLLOW THESE
INSTRUCTIONS:
1. AFTER SIGNING OFF ACCORDING TO YOUR INSTRUCTIONS,
2. TEAR OFF THIS PAGE WITH THE COMPLETE LESSON,
3. SIGN THE BOTTOM OF IT, AND
4. DEPOSIT IT IMMEDIATELY IN THE BOX BY THE DOOR.

IF YOU HAVE ANY COMMENTS ABOUT THE LESSON OR THE SYSTEM
PLEASE WRITE THEM IN BELOW:
THANK YOU.

COMMENTS:

SIGNATURE(S) ----------------------STUDENT ID------------

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TIME= 13.48.21 DATE= 14 JUL 71

STOP EOJ M.U.L.E. VERSION 2 - LEVEL 1

Diagram 1

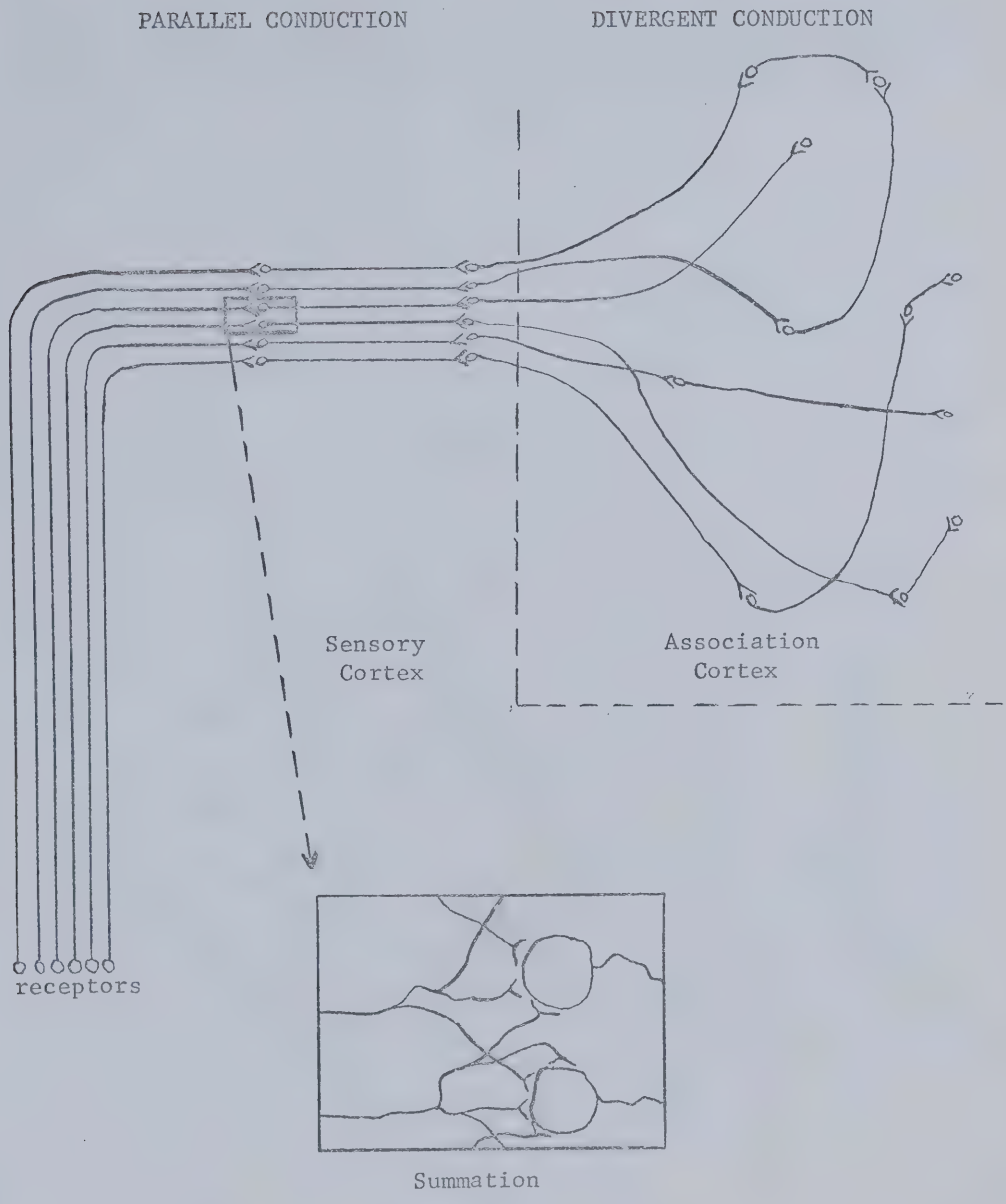
PARALLEL CONDUCTION
DIVERGENT CONDUCTION
Sensory
Cortex
Association
Cortex
receptors
Summation

Diagram 2

X, Y, and Z are sensory transmissions; A, B, C, D, E, and F are cell assemblies. "A" was active before the sensory input occurred. B, C, and D became active after sensory input occurred. E was inactive before the sensory input occurred and so Z does not have an effect.